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A CODLING MOTH TRAP[1]

By E. H. SIEGLER, *Entomological Assistant, Deciduous Fruit Insect Investigations*

The control of the codling moth (*Carpocapsa pomonella* L.) in the Grand Valley of Colorado has been the most difficult insect problem with which the fruit-grower has had to contend. Time and again, despite five to eight thorough spray applications, a large percentage of the apple crop has annually been destroyed by this pest. The gravity of the situation is increased by the fact that no improvement has been made during the past decade. Furthermore, spraying has become relatively too expensive for the benefits derived therefrom, and it is quite probable that, unless some auxiliary methods are employed, the situation will remain unchanged. The theory that, on a given tree, the spray will as readily destroy one thousand larvæ as one hundred is neither logical nor true from a practical viewpoint. Spraying loses much of its profitable effectiveness wherever the worms have not been reduced to comparatively small numbers. Especially is this true under the favorable codling moth conditions of a semi-arid region.

The difficulty of controlling this insect was fully realized by the writer last season, while engaged in deciduous fruit insect investigations under the direction of Dr. A. L. Quaintance of the U. S. Bureau of Entomology and in coöperation with the Colorado Agricultural Experiment Station. After a rather brief experience with the relative abundance of the codling moth in this district, it was at once apparent that some method of control, supplementary to spraying, must be employed to reduce the number of this pest to a point where spraying would again become effective at a reasonable cost.

The purpose of this article is not to enumerate the causes which contribute to the wormy orchard conditions, but rather to call attention to a possible means of relief.

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During the progress of the codling moth investigations, it was learned that the more successful growers have resorted to a combination of spraying and banding. The value of the latter has been generally conceded, but, at the same time, the majority of the fruit-growers have declined to make use of the bands owing to the labor and expense involved. This is due to the fact that the larvæ must be gathered about eight times each season, including the spring collection of overwintering individuals. The number taken beneath the bands however, usually pays well for the trouble of collecting the insects. In connection with some experimental work last season, over four thousand larvæ were secured from twenty banded trees in an orchard which received six spray applications. These figures are not exceptional, but tend to emphasize the importance of banding until the codling moth can be reduced so that a reasonable number of spray treatments will hold it in check.

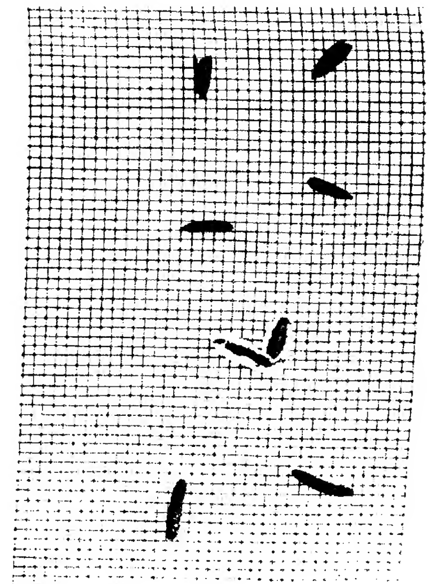
With these facts in mind, the writer conceived the idea of capturing the codling moth larvæ, without extra labor on the part of the fruit grower, by means of a trap. The present paper is essentially a preliminary report on this device. Since its conception and operation it was learned that a similar scheme had been proposed by C. W. Woodworth and Geo. E. Colby.[1] But whether or not a trap, such as is herein described, has ever been employed by these authors is not specifically mentioned in their publication.

The principle of the trap is a simple one taking advantage of the fact that the codling moth larva will enter an opening through which after its transformation, the adult cannot escape.

The trap consists of a strip of twelve mesh wire screen cloth six inches wide and sufficiently long to encircle the trunk of the tree. Black painted wire cloth, owing to its dark color, is preferable. The edges of the wire screen are crimped so as to afford an elastic cushion helpful when attaching to the tree and also to prevent the screen from tearing when being stretched into place. The tree should first be banded in the usual way with burlap, or some other suitable material, folded once or twice to a width of about two inches. The strip of wire screen is next placed directly over the cloth band and is attached to the tree at one end by a couple of tacks. By means of pliers, the screen should be stretched tightly around the tree and at the same time the crimped edges should be tapped with a hammer until form fitting. Wherever the edges of the trap do not come in close contact with the tree, as in the case of a groove, a tack should be used. If the loose bark of the trunk has been removed, as is essential for the best results, the matter of adjusting the trap is a simple one.

The codling moth trap is shown in Plate 38, figure 1. A tree having a groove was purposely used to show how the trap may be made

[1] Bul. 126, Calif. Agr. Exp. Sta., 1899.



to conform to irregular trees by means of a few tacks. The average size of the codling moth larvæ, cocoons, pupæ and adults compared with twelve mesh wire screen cloth is shown in Plate 38, figure 2.

Field Experiments with the Trap

During the season of 1915, a few preliminary experiments were made to test the principle upon which the trap was founded. Beyond proving that the device had potential value, nothing further of experimental import was done. But during the present year, a series of experiments has been inaugurated to determine the efficiency of the trap. The preliminary experiments were, therefore, planned with the view to discover how readily the larvæ are lured into the trap. To obtain such data, it was arranged to give the larvæ the option of entering the trap or beneath the ordinary cloth band. Naturally, it might be well anticipated that the larvæ would seek a place of refuge along the lines of least resistance consistent with the assurance of proper protection. The writer reasoned that if any of the larvæ should voluntarily select the trap in place of the band that the former would not be considered an undesirable cocooning place. From this, it was further deduced, that with nothing other than the trap on the tree, that the larvæ would then naturally be enticed into it.

Eight trees in a sprayed orchard were selected and each of these were finally banded with cloth half way around the trunk. At the same time the corresponding half of the trees was covered with a trap. Hence, all larvæ seeking a place in which to spin up were free to choose between the band and the trap. The following tabulated data give the first results obtained:

Experimental Results with the Codling Moth Trap, Grand Junction, Colo., 1916

Tree No.	Experiment Started	Date of Observation										Total No. of Insects	
		July 5		July 14		July 17		July 20		July 28			
		Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	Insects in Trap	Insects beneath Band	In Traps	Beneath Bands
...	July 1	2	4	10	19	5	8	3	14	17	25	37	70
...	July 1	1	5	9	10	3	2	0	2	14	8	27	27
...	July 14					6	8	9	10	27	23	42	41
...	July 14					4	5	8	5	4	13	16	23
...	July 17							1	4	9	21	10	25
...	July 17							2	5	16	11	18	16
...	July 17							0	2	3	21	3	23
...	July 17							3	10	13	8	16	18
Total	......	3	9	19	29	18	23	26	52	103	130	169	243

Insects captured include larvæ and pupæ.

From the above figures it will be noted that 41 per cent of the larvæ voluntarily cocooned within the traps. This percentage far surpassed expectations. It will be further noted, by a study of the table, that the number of insects caught by the traps sometimes exceeded the number found beneath the bands; also, that the comparative number of insects within the trap and beneath the band on the same tree would occasionally alternate with the different observations. Improvements with the traps have recently been made, but not perfected, which may induce a still higher percentage of the larvæ to enter the traps in preference to the cloth bands.

As further evidence of the value of the traps the following data are offered: Two traps placed July 1 on trees within the same orchard were removed July 28. The total number of insects trapped including larvæ, pupæ and moths was 98—of this number 12 were in the adult stage, 11 of which were dead. Another trap placed July 5 and examined July 28 showed a capture of 43 larvæ and pupæ. Thus, in less than a month, three traps captured 141 insects in an orchard which had already been sprayed four times. Assuming that about one half of these were females, and that each would lay 50 eggs, it will be seen that the infestation on three trees has at once been reduced by 3,500 larvæ.

Some Advantages of the Trap

The cost of the wire cloth is insignificant when compared with the service rendered. Current wholesale prices average about $1.40 per hundred square feet. The wire cloth for bearing trees will therefore cost about 1½ to 2 cents per trap depending upon size. In addition to this something must be allowed for making and attaching, but this can well be done during the winter months.

Once the traps are properly applied, they should require little or no attention except at the beginning of each year. The gradual increase in the size of the tree and the elasticity of the wire screen should serve to hold the trap snugly in place. The durability of the traps has not been tested but they will doubtless not need renewal more than once every two to three years.

The use of the traps will eliminate the overlooking of larvæ and pupæ which frequently happens when the bands are used. Likewise, no moths will escape from the traps, as is commonly the case with the bands, because the fruit-grower, due to the pressure of other duties, was unable to "work the bands" on time.

One of the desirable features of the trap is that it will serve as a guide for timing the spray applications. By observing the time of emergence of the spring brood moths, the fruit-grower can figure approximately when the first cover spray for the fruit should be applied.

Throughout the season the emergence of the moths within the traps will have significance.

The time saved, during the busy growing season, by the usage of the trap, instead of the destruction of the insects beneath the band by hand, is one of the most important advantages of this device.

It is believed that the solution of the codling moth problem in the Grand Valley may be solved by a concerted movement against the first brood. The success of this action, it is hoped, will be effected by thorough and timely spraying supplemented with the codling moth trap.

Explanation of Plate 38

Fig. 1. Codling moth trap.

Fig. 2. Codling moth larvæ, pupæ and adults in comparison with twelve mesh wire screen cloth.

LIFE-HISTORY OF THE VELVET-BEAN CATERPILLAR (ANTICARSIA GEMMATILIS HÜBNER)

By J. R. Watson, *Gainesville, Fla.*

Velvet-beans (*Stizolobium* sp.) are among the most important forage and soil-improving legumes of Florida and are more or less extensively planted in the other gulf states. They are commonly grown on newly cleared land, where they are of service in choking out sprouts and other wild growth, and in cornfields, where they serve as a late summer cover crop, taking possession of the ground and climbing over the stalks after the corn matures in July or early August. They make a slow growth until after the summer rains set in, in June or July, after which they grow rapidly, a single vine sometimes reaching a length of forty feet. The presence of the bushes or cornstalks increases the yield of seed, as more pods set when the blossom racemes are kept off the ground. The vines and immature pods are killed by even a slight touch of frost. The dried pods will hang on the vines without shedding their seeds for weeks or months, the time depending upon the species or variety, and are used as winter forage for stock. The leaves and stems decay and add much humus to the soil.

Except a more or less regular toll levied by grasshoppers, the only serious insect enemy of the plant in Florida and southern Georgia is the larva of this noctuid moth. It presents somewhat of a problem as the larva is a voracious feeder and velvet-beans are very easily injured by arsenic compounds. The maximum dose that they will stand is about twelve ounces of powdered lead arsenate, together with the milk from a pound of lime, to fifty gallons of water. Even then

there will be some scorching of the older leaves. The younger leaves are not so easily injured.

The moths make their appearance about Gainesville near the middle of August and the larvæ are often abundant by the first of September. They strip the blades from the leaves, leaving only the stems and petioles. This attack, coming as it usually does at the blossoming period, often results in a total loss of seed and hence of the entire value of the plant as a forage crop. Even its value as a producer of humus is also lessened as the plant normally makes much of its growth after that date.

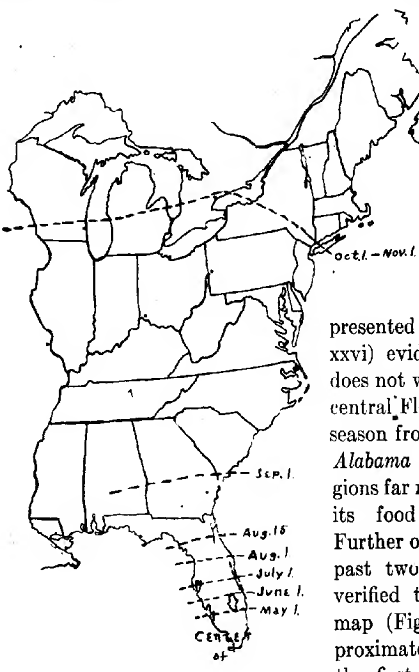


Fig. 36. Map showing annual flight of *Anticarsia gemmatilis*. (Original.)

Distribution.—The writer has presented elsewhere (*Ent. News*, xxvi) evidence that the insect does not winter over in north or central Florida but flies up each season from the south and, like *Alabama argillacea*, flies to regions far north of those in which its food plants are found. Further observations during the past two seasons have amply verified that conclusion. The map (Fig. 36) shows the approximate date of the arrival of the first moths in any part of their range. The last moths of the 1915 caterpillars were caught at Gainesville on January 29, 1916. At Jesup, Ga., the caterpillars sometimes defoliate the velvet-beans. At Valdosta and Hilton, Ga., they are known but are not considered as being of much importance. I have been unable to find any record of the caterpillars being seen north of those places. Neither do they seem to be known in the west gulf states although velvet-beans are quite extensively grown there.

Life-History.—The eggs are laid singly, mostly on the under side of the leaves, although many are found on the upper surfaces and some

on the petioles and stems. The egg is nearly 2 mm. in diameter and somewhat less in height, and flattened on its lower surface. It is prominently ribbed and white until about a day before hatching, when it turns a delicate pink. During August and September it hatches in about three days. Those laid in November required a week or more and often failed to hatch at all.

THE CATERPILLAR.—The newly hatched larva makes its first meal of the shell of the egg from which it has just emerged, leaving only that portion which is attached to the leaf. It then begins to strip the leaf of the lower epidermis and mesophyll. This is continued until near the end of the second instar when the caterpillar begins to skeletonize the leaf, eating all of the soft material but leaving the veins intact. After the second instar the caterpillar consumes the whole leaf with the possible exception of the midrib and larger veins. Larval development requires from three to four weeks in summer. There are usually six instars, but late in the season a few individuals moulted seven times.

The caterpillars are extremely variable in color and markings, especially after the second instar. At this time the majority show prominent dark-colored longitudinal lines and narrower ones of white, yellow, or pink, on a ground color of dark green. On many these longitudinal lines are dim or even entirely lacking. These individuals are usually a light yellowish green but some are mahogany brown. Only the more usual dark-colored forms are described in the following paragraphs.

FIRST INSTAR (Pl. 39, fig. 1).—The newly hatched caterpillar is about 2.5 mm. long and grows to be from 6 to 7 mm. before molting. The head is light brown in color, rounded, bilobed; mouth shining; eyes black. The body is of a uniform light green color without any trace of longitudinal stripes. The tubercles are black and conspicuous; setæ also black. The prolegs on abdominal segments 3 and 4 are about equal in size but are much smaller than those on segments 5 and 6 and are not used for walking. A glance at the prolegs is the most ready means of distinguishing the first and second instars. The legs are light brownish yellow.

The caterpillar spends about two days in this instar, the average of twenty-seven individuals being 1.7 days.

SECOND INSTAR.—The markings are now very similar to those of the next instar but are somewhat less pronounced. The most conspicuous longitudinal mark is the black border to the lateral line. The papillæ are black as in the first instar but there is around the base of each a light-colored ring. The first pair of abdominal prolegs, as in the first instar, is less than a fourth as long as the third, weak, and not used in walking or clinging; but the second pair is about half as long as the third. These, too, are ordinarily not used in walking but occasionally are so used.

The larva spends three or four days in this instar (average 3.6 days) and grows to a length of about 9 mm.

THIRD INSTAR.—Head rather square in outline, strongly bilobed, yellowish; ocelli black; mouth dark brown. Body cylindrical; all prolegs used for walking but the

first pair may be somewhat shorter than the others, light yellow; dorsal line pale white, somewhat broken, margined on each side by a darker border (Pl. 39, fig. 2). Subdorsal line very pale and indistinct, bordered as dorsal line; lateral line indistinct and broken, narrow, pale white. Sub-stigmatal line wider and continuous but of a paler color than dorsal and subdorsal. Ventral surface yellowish green. Stigmata brown. Tubercles black. These and the setæ are placed as represented in figure 37. The lettering follows Fracker's recently published plan (Ill. Biol. Monograph, vol. II, No. 1). The diagrams also show the position of the longitudinal lines.

This instar also lasts from three to four days during which time the caterpillar grows from an average of 9 mm. to 15 or 16 mm. in length.

Fourth Instar.—Dorsal, subdorsal and sub-stigmatal lines more distinct than in the third instar. All feet used in walking but the first and to a lesser degree the second pair noticeably shorter than the others. Otherwise this instar is very like the third.

In our cages the average time spent in this instar was 3.7 days and the larvæ grew to an average length of 18 mm.

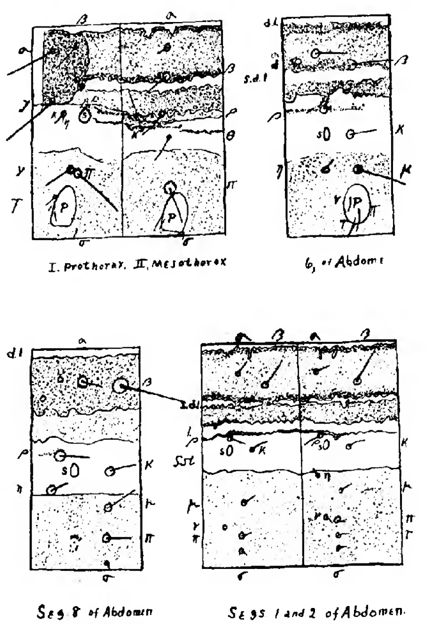
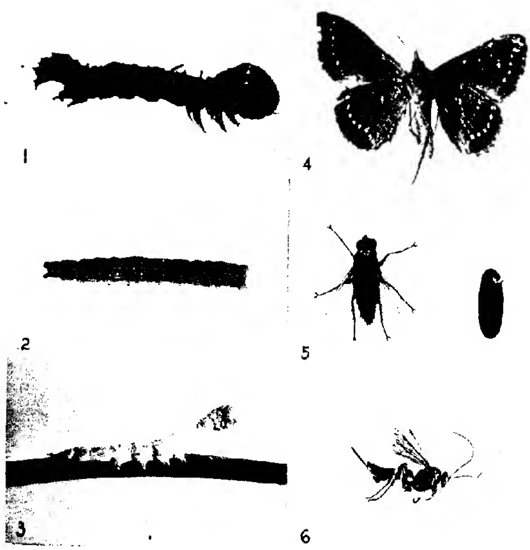


Fig. 37. *Anticarsia gemmatilis*, diagrams of representative larval segments, showing position of setæ; *d. l.*, dorsal line; *s. d. l.*, sub-dorsal line; *p.*, prolegs; *s.*, stigmatæ.

Fifth Instar (Pl. 39, fig. 2).—Also similar to the third instar but the longitudinal lines are more clearly defined. Papillæ are now white with brown apexes. In the area between the dorsal and subdorsal lines there are a few white dots with a brown border. One of the largest of these (Pl. 39, fig. 2) is situated near the anterior border and subdorsal line on abdominal segments 1–8. On the metathorax it is double. Stigmatal line is brownish yellow, broken, widely bordered with white on the ventral margin. In the lighter colored individuals this line is often a rich yellow bordered by lines of deep pink.

This instar lasts three or four days and before molting the caterpillar commonly reaches a length of 25 mm.



Anticarsia gemmatilis. 1. First stage larva. 2. Fifth instar. 3. Caterpillar killed by "cholera." 4. Ventral view of moth. 5. *Euphorocera floridensis.* 6. *Hoplectis rufuscula.*

SIXTH INSTAR.—The stigmatal line is colored like the lighter forms of the fifth instar but the pink is usually replaced by brown.

The caterpillar spends from five to twenty days in this instar, the time becoming gradually lengthened as the weather becomes cooler. The length of the full-grown larva varies from 38 to 48 mm. In the pre-pupal period it shrinks to a length of 25 mm. and turns mahogany brown with few if any signs of longitudinal lines.

PUPA.—Brown in color, smooth and shining. Abdominal segments punctuated with fine dots which are particularly thick on the anterior half of each segment. Head somewhat pointed. At the end of the abdomen are three pairs of hooked spines, one pair is much larger than the others. Length 18-20 mm., width 4-6 mm. The pupa is light green until it is about a day old.

The pupæ are usually placed barely underneath the surface of the soil, but as there are usually many dried leaves under the vines they are well hidden. They are placed in loose and frail earthen cells. In the breeding cages and sometimes in the field these cells are made of dried leaves or omitted altogether. The pupal stage averaged about seven days in August and between ten and eleven in September. As the weather became cooler this time was gradually lengthened until those that pupated in November averaged 21 days and two that pupated on November 20 and 21 respectively issued on January 7, 48 and 47 days respectively.

THE MOTH.—Like the caterpillar, the moth also is very variable (Pl. 40). The ground color varies from a light yellowish brown to ashen gray or a dark reddish brown. Old, badly rubbed individuals, are brownish yellow with the color pattern almost obliterated. Usually, however, there is at least a trace of the diagonal line remaining. Beneath the wings are cinnamon brown with a sub-marginal row of light spots and a median dark line. This color pattern is less variable than that of the upper surface (Pl. 39, fig. 4).

Mating probably occurs at night. A single pair was observed mating in the cages. This occurred about dusk. They remained *in coitu* only a few seconds. Dusk is the period of greatest activity of the moths. During the day they lie hidden under the leaves of the host plants. If disturbed they fly a short distance only. They do not go to lights readily and on the whole it would seem that they are not in the habit of taking long flights. Doubtless, however, in the absence of the host plants of the larvæ, they are capable of long sustained flight. There is no suggestion of definite broods. The moths seem to arrive in numbers from the south during August and at any time after late August one may find all stages in the field on the same day.

Host Plants

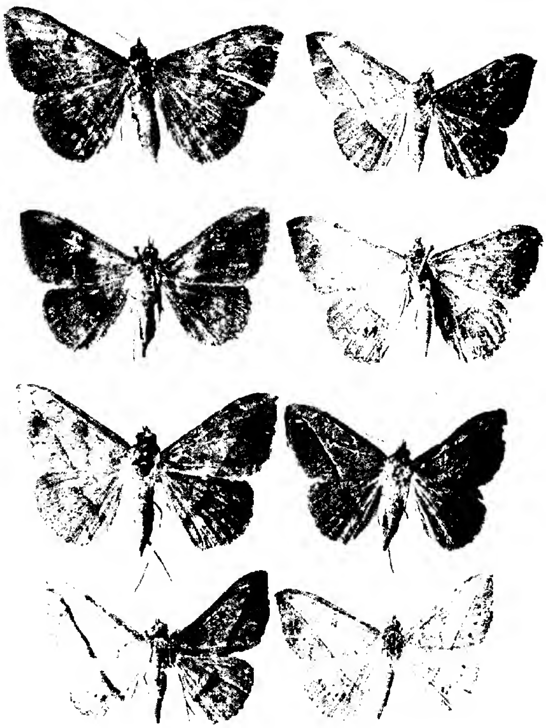
The writer has found the caterpillars feeding upon but three plants. Named in the order of preference they are: velvet-beans (*Stizolobium* sp.), kudzu vine (*Pueraria thunbergiana*), and the "horse bean" (*Cannavalia* sp.). Some varieties and species of velvet-beans are evidently preferred to others. The common "Florida velvet" is always much more severely damaged than the "China" when the two are planted side by side. As the caterpillars ordinarily do not leave the plant on which they were hatched, any choice between plants must be made by the female moths at the time of ovipositing. When leaves of the two varieties were left over night in a cage of moths there were, on the average, two eggs deposited on the "Florida velvet" to one on the "China." Care must be taken that the leaves are of equal age as the moths are less attracted to either very young or old leaves. The early maturing varieties, such as the China, have the further advantage that if they are planted early they will, at least in northern Florida, often mature most of their seed before the caterpillars become abundant.

The caterpillars feed both night and day, stopping only to molt. Some determinations were made of the amount of food they normally consume. The larvæ were well fed at the beginning of the experiment so that the amount they consumed should be not far from that usually eaten in the field. Twenty-two caterpillars in the fourth, fifth, and sixth instars weighing 4.8 grams ate 17 grams in 52 hours, an amount equal to their own weight at the beginning of the experiment in less than fifteen hours. Another lot of fifty-three larvæ weighing 8 grams ate 24.5 grams of leaves in 48 hours, the equivalent of their own weight in less than sixteen hours. No cannibalistic tendencies were observed even when the food was exhausted in cages in which many caterpillars of different sizes were confined. In this respect they differ markedly from some other Noctuids such as *Heliothis*.

Caterpillars in the first and second instars, when disturbed, lower themselves on a silken thread. But after the second instar this thread is usually not secreted. Instead the caterpillars quickly throw themselves to the ground by means of very rapid and violent contortions. The noise they make in dropping from the upper to the lower leaves as one walks through the field is quite characteristic and furnishes a ready means of detecting their presence.

Natural Enemies

The caterpillars are eagerly sought by many predaceous enemies. One of the most important is the red-winged blackbird or "Ricebird" (*Agelæus phœniceus*). These birds congregate in infested fields in



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Anticarsia gemmatilis, variations in pattern

great flocks composed largely of immature individuals. Other birds, especially mocking-birds and field sparrows, feed eagerly upon them. The lizard Anolis ("chameleon") is also an important enemy, which is commonly seen climbing over the vines. Various species of wasps prey upon them. *Callida decora*, a small blue carabid, is common on the plants and feeds upon the eggs as well as the young larvæ. Next to the blackbirds the most important predaceous enemies are probably several species of hemiptera. *Alcæorrhynchus grandis* Dall., is probably the most abundant but *Brochymena annulata* Fab., and *Euthyrhynchus floridensis* Linn., and *Podisus maculiventris* Say are common.

In sharp contrast to the predaceous enemies the insect is remarkably free of internal parasites. From many hundreds of pupæ collected but two parasites were raised. One (Pl. 39, fig. 5) proved to be an undescribed species of Tachinid which Townsend has named *Euphorocera floridensis* and the other an ichneumon, *Itoplectis rufuscula* Davis (Pl. 39, fig. 6).

CHOLERA.—By far the most efficient check on the increase of this insect is a disease of the caterpillars called "cholera" by the farmers. It is caused by a fungus, *Botrytis rileyi*. Sometime during September or early October this has always become epidemic in the fields and in a week's time all but exterminated the caterpillars, a very small fraction of one per cent escaping. After the epidemic one may have to search for an hour or more to find a single live caterpillar where a week before they had been so numerous as to strip most of the leaves from the vines.

The first symptom of the disease is the flaccid, emaciated appearance of the caterpillar. It does not feed. It soon elevates the anterior portion of the body, head, thorax and first two abdominal segments at an angle of about 45 degrees and dies in that position (Pl. 39, fig. 3). In a day or two the spores mature and the corpse turns white. Healthy caterpillars confined with these corpses become sick in three days. The fungus attacks all instars alike. Although it is usually possible to find a few of these mummies in the field at any time during the caterpillar season, it requires favorable weather conditions to start the epidemics. These conditions seem to be a prolonged and rather cool rain such as frequently occurs in late September. Perhaps the resistance of the caterpillars is lowered by the cooler weather as this is a distinctly subtropical insect. At least we have not succeeded in our attempts to start a premature epidemic. Even when the caterpillars were confined under a bell-jar in a saturated atmosphere with mummies, the disease did not become epidemic among them until "cholera time" arrived.

Although there may be a partial recovery after an epidemic, the caterpillars never again during that season become sufficiently numer-

ous to be troublesome. The fungus invariably holds the insect in check. A majority of the young caterpillars die within ten days after hatching.

Although "cholera" often arrives too late to save the crop if the farmer depends upon it alone, it is nevertheless a great help as it reduces to a few weeks the time during which the farmer needs to apply arsenicals.

SOME NOTES CONCERNING OVERWINTERING OF THE HOUSE-FLY, MUSCA DOMESTICA, AT DALLAS, TEXAS[1]

By W. E. Dove, *United States Department of Agriculture, Bureau of Entomology*

From the facts that adult house-flies are found in dormant, semi-dormant and active states in mid-winter, and possess a greater longevity during low temperatures, earlier investigators have generally assumed that the species passed the winter in the adult stage. This conclusion is further supported by the fact that numbers of inviable pupæ have been taken in nature during the early spring. The treatment of manure piles with borax and hellebore and the effectiveness of the maggot trap in control of house-flies has necessarily caused us to recognize the overwintering of *Musca domestica* as a biological point worthy of more consideration and one which should be supported by more experimental evidence.

Under the direction of Dr. W. D. Hunter, and at the suggestion of Dr. L. O. Howard, some biological points of economic importance were made a subject of study at Dallas and Uvalde, Texas. We have recorded two instances in which we succeeded in carrying the immature stages of the species over the winter in infested manure (1). Due to the fact that *Empusa muscæ* was unusually abundant and probably killed most of our adults, we did not attempt to ascertain the winter longevity. Further experiments with immature stages and with the longevity of adults are herein reported. I am gratefully indebted to Mr. F. C. Bishopp under whose direct supervision the work was done for valuable suggestions.

Adult Longevity

I wish to quote Mr. R. H. Hutchison (2), who reports that "in one hibernation experiment, in which flies were kept in a stable varying from 30° to 60° F., a few lived as long as 70 days." This experiment was conducted at a more northerly latitude than Dallas, Texas, and where temperatures are more constant.

[1] Published by permission of Chief of Bureau of Entomology.

In Table I, in which experiments no Empusa occurred, adults were not subjected to fatal temperatures, and received an abundance of food. It will be observed that the longevity was prolonged as the temperatures decreased and in once instance a fly lived for 91 days. This maximum longevity is a record obtained under the most favorable abnormal conditions which I find are not utilized by adults in nature. It is well to know the conditions under which this maximum longevity was obtained.

A room, in which a box was placed containing hundreds of pupæ in infested cow manure, was gradually heated to a maximum of 70° F. and the temperature allowed to remain about the same for thirty-six hours. During this time 600 adults emerged into a 4′ x 4′ x 5′ cage and all apparently fed soon after emerging. Ripe bananas, sweet milk, and fresh cow manure were present, and at short intervals during the longevity these were freshly replenished. No hibernation material was supplied for as near as possible the actual temperatures experienced by the adults was desired. Five days later, on December 17, the room was again gradually heated to 70° F. and allowed to remain for a short time to insure a second feeding. Great activity was manifested and apparently all again fed. The cage was located in the coldest room on the north side of a two-story frame house, and excepting the two periods of artificial heating to insure feeding of adults I believe the temperatures most favorable for a maximum longevity were obtained. Between the first and second feeding of the adults a minimum of 20° F. occurred, but was present only a few hours. During this time sixty adults died, but this was probably only an elimination of those not sufficiently fed, as will be seen from a study of effective temperatures discussed in a later paragraph. After the second feeding of the adults a minimum of 32° F. occurred on December 26, and a minimum of 28° F. on January 24, but neither of these continued long enough to greatly affect the mortality. An average of the daily minimum temperatures during the longevity period was 42.58° F., an average of the daily maximum temperatures 57.66° F., while the daily mean average was 50.12° F. The room in which this experiment was conducted was used for no other purpose, for the reason that the movement of persons and the warmth of their bodies would have increased the temperatures, thereby increasing the activity of flies. It was also partially darkened by window shades which kept out the sunlight and lessened activity. This, however, did not prevent feeding of adults during the warmer portions of the day. On some days it was warm enough to permit flight, and had the flies not been caged they would have then sought the warmer portions of the house. Being caged they were allowed to feed but were necessarily kept quiescent

during the greater portion of the time. Had they been liberated under warmer temperatures it is easy to see from the experiments cited in Table I that the longevity would have been materially reduced.

On December 8, 1914, 750 adults emerged from another portion of the same media as the experiment discussed above, were fed bananas and milk in abundance. Apparently all fed and were in good condition. They were liberated in a large covered cage in the open and in addition to the food which was ever present they were supplied with shelter consisting of boards, burlap sacks, paper, and excelsior. These were conveniently arranged to allow the adults to obtain protection with little effort. As will be observed in Table I, a minimum of 14.5° F. occurred on December 15, and there was a gradual decrease in temperatures until this degree was reached. On January 4, at a maximum of 64° F., only one adult proved to be alive and this died before January 9. These conditions, which seem to have been more favorable than those obtaining in nature, gave a maximum longevity of not more than 32 days.

From the two experiments cited above we know what longevity to expect under these temperatures and conditions. Let us now consider the questions: What are the reaction of adults in nature to temperatures, and what are the effects of these temperatures on adults?

Reactions of Adults During the Winter to Varying Temperatures

In a winter experiment to determine the longevity of adults under kitchen and restaurant conditions a number escaped from the cage and were free to visit places of various temperatures. The general tendency was to seek temperatures slightly above 60° F., which being higher than that of the caged ones caused them to die much sooner. It is true that the caged adults were always supplied with food, but bananas and peels were placed in portions of the room where escaped adults were observed to congregate. The last fly in the cage lived for 54 days, but no living flies could be found in the room and adjoining rooms after 30 days.

Observations have been made of flies rendered inactive by low temperatures but in no case have I ever observed living adults to remain quiescent for more than a few days. The natural heat of the sun or very slight artificial heat will cause them to become active.

In cases where adults were subjected to freezing temperatures they were killed, the duration of life depending upon whether or not they had previously fed. Unfed and slightly fed adults died outright, and those which were allowed to feed previously were not capable of withstanding continuous freezing temperatures for three days. Below

45° F. all adults were quiescent; fed ones crawled slightly at 48° F., could be forced to fly at 51° F. and would fly voluntarily at 53° F. When voluntary flight occurred adults would feed if food was near, but would not search for it. Efforts were made to determine the actual effective temperatures for adults. In working with specimens motionless from cold the thermometer was placed on the ground with them, and in other cases a suspended thermometer was used on which adults alighted prior to the low temperatures.

At Dallas, Texas, there is no long period of low temperatures during which adults become altogether dormant. When freezing temperatures do occur at night it is often warm enough at midday to permit activity out of doors. The cold weather usually comes in the form of "northers" and the temperature often drops 30° F. or more within twelve hours. If, prior to a norther and on a fairly warm day, one visits the city dumping grounds he will find numerous flies feeding and occasionally depositing. Garbage wagons leaving during the day will be carrying them to various portions of the city, though the number is not to be compared with the greater number during the summer months. Shortly after a norther and when outside temperatures are warm enough to permit flight, if one again visits the dumping grounds, not a living adult is to be found. Only adults in houses are found alive and they are mostly in warm places and active. The death of exposed adults under conditions as above outlined has been proved by gradually warming those which were found inactive and unprotected from cold.

In general it may be said that the longevity of adult house-flies varies indirectly with decreases in temperature provided they have sufficient food, are not subjected to freezing temperatures and are not killed by *Empusa muscæ*. Should they be prevented from following their natural tendency to seek temperatures above 60° F., the humidity being normal, the adults become inactive at 45° F. But since the temperatures vary in different places, either naturally or by man's interference, adults do not generally remain quiescent. They seek the warmer temperatures and their longevity is correspondingly decreased.

Possible Relation Between the Development of Empusa Muscæ and Oviposition

In the spring of 1915 a number of specimens of *Lucilia sericata*, all of which had emerged from the same infested meat, were placed in disinfected cages. Fresh bananas were supplied in all cages. In an attempt to determine the effect of a lack of deposition media on the longevity, some adults developed a fungus. This was first observed among females, but only in the cage where meat was not supplied for

Table I. Maximum Longevity of Musca domestica at Dallas, Texas

Date Adults Emerged	Number	Date Last Fly Died	Greatest Longevity	Min. Temp. Occurrence	Average Daily Minimum	Max. Temp. Occurrence	Average Daily Maximum	Average Daily Mean	Food
May 16, 1914	250	June 8, 1914	23 days	51.9° F., May 17, 1914	68.37° F.	92.1° F., June 8, 1914	84.77° F.	76.57° F.	Bananas and horse manure*
June 23, 1914	100	July 18, 1914	25 days	73.1° F., June 27, 1914	75.79° F.	104° F., July 14, 1914	99.75° F.	87.77° F.	Plums, milk and horse manure*
July 9, 1914	350	July 28, 1914	19 days	70° F., July 28, 1914	74.99° F.	104° F., July 14, 1914	100.52° F.	87.75° F.	Bananas, milk and horse manure*
July 23, 1914	75	Aug. 12, 1914	20 days	70° F., July 28, 1914	74.24° F.	104.3° F., July 30, 1914	96.9° F.	85.57° F.	Peaches and cow manure*
July 27, 1914	200	Aug. 16, 1914	20 days	69.7° F., Aug. 16, 1914	73.59° F.	104.3° F., July 30, 1914	94.31° F.	83.95° F.	Canteloupe and horse manure*
Oct. 22, 1914	700	Dec. 14, 1914	53 days	16.5°F., Dec. 14, 1914	43.71° F.	86.3° F., Nov. 5, 1914	64.57° F.	54.14° F.	Milk, bananas, cow manure, horse manure*
Dec. 8, 1914	750	Jan. 9, 1915	32 days	14.5° F., Dec. 15, 1914	32.8° F.	64° F., Jan. 4, 1915	46.99° F.	39.89° F.	Bananas and milk
Dec. 10, 1914	600	Mar. 12, 1915	91 days	20° F., Dec 13, 1914	42.58° F.	70° F., Dec. 10–13 and 17, 1914	57.66° F.	50.12° F.	Bananas and cow manure

*Copulated and deposited.

depositions. Copulations had been observed in this experiment, and by comparison with similar lots of adults it is certain that the adults were sexually matured. An authentic determination of the fungus was not obtained, but it was apparently *Empusa muscæ*.

In the experiments with *Musca domestica*, cited in Table I, no Empusa appeared. It seems possible that the fungus develops principally in sexually matured and fertilized flies which do not deposit on account of low temperatures. The fungus appears to occur among house flies only under cool conditions of autumn and the fact that they do not deposit during low temperatures may be the explanation.

Larval Stages

Winter depositions have been observed in various instances on warm days at Dallas, Texas. In Table II it will be observed that in Breeding Nos. 59, 56 and 58 freshly deposited eggs were obtained, on January 14, 1914. These were deposited by clusters of females on a manure pile which was generating heat. The eggs were divided, allowed to hatch and develop; some in the manure pile, some in a small tin box in the house, and some in a similar tin box in a shelter for weather instruments. Adults were reared from the manure pile, by preventing the larval migration, within twenty-three days from hatching and in the house in forty-nine days from hatching. While no adults were produced in the shelter, the length of the larval period was extended to twenty-five days. In the shelter the larvæ died when very small and being moist experienced lower temperatures than the air which had a minimum of 11.5° F. Similarly, in Breeding No. 57, in which small larvæ were taken from infested manure and straw, all died within thirty days. In Breeding No. 97–B, freshly hatched larvæ which were kept in a mixture of cold wet manure, to which was added occasional small lots of fresh manure, lived more than sixty-seven days.

While young larvæ are capable of withstanding conditions that will lengthen the periods as shown above, in most cases larvæ will become developed before the media becomes cold. Especially is this true in manure piles during the early portion of the winter. In Breeding No. 62, 1,400, one half to fully grown, larvæ were selected by hand and retained in the same media. This consisted of a mixture of horse manure and decaying straw which was of a cold nature, and was not placed on soil where the larvæ could penetrate for protection. Living larvæ were present on February 5, 1914, which was ninety days after they were placed in the cage. By referring to Table II, we find other instances in which larval periods were greatly extended, and while I am certain that greater periods than these were obtained, the fact that larvæ and pupæ were both present at the beginning of some experi-

ments, makes it impossible to determine the maximum length of the larval stages. To have examined the infestation would have caused abnormal conditions. However, in Breeding No. 66, in which infested manure was placed in a cage and subjected to two inundations, larvæ were present from November 26, 1913, to March 21, 1914, a period of at least 115 days. In this experiment adults emerged from the over wintering material, and has been reported in a previous paper (1.). In the experiments with larvæ which produced no adults there was no soil into which they could migrate to a depth which would be protective to their pupæ.

Pupæ During the Winter

Confining our attention to the winter pupal periods we find that where pupæ were in manure piles in which heat was generated, as in Breeding No. 99, emergence continued until all viable pupæ produced adults. In this experiment 85 adults were observed to emerge when the maximum for the twelve hours of emergence was 55° F. and the minimum 43° F. These were the actual temperatures of the media, which consisted of cow manure and some straw. At other temperatures above these emergence was most frequently observed. Only when pupæ were kept at these or warmer temperatures did they produce adults, and these emerged in a comparatively short time. The inviability of pupæ remaining unemerged in Breeding Nos. 65, 100, 99, 62 and 56, was determined by warming them during the spring. In Breeding No. 56, the emergence ceased when the box containing pupæ was removed from the manure pile, and none emerged thereafter. In Breeding No. 62, pupæ were produced by larvæ migrating into an old burlap sack which was on the bottom of the tin compartment, but on account of low temperatures none emerged.

Numerous winter and spring collections of pupæ from garbage and old manure piles in various outdoor locations, but which were taken near the surface of the soil or in the media, failed to produce adults when subjected to favorable conditions. It is evident that pupæ in such conditions either receive enough heat to produce adults during mid-winter or die from temperatures too low to permit emergence. However, pupal periods have been observed to extend for 26 days or longer, and it is reasonable to expect long periods from pupæ formed from migratory larvæ which penetrate deep enough for protection from excessive cold or warmth. It is evident from the experiment described below that larval migration is a great factor in placing pupæ at a favorable depth in the soil.

TABLE II. EXPERIMENTS IN OVER-WINTERING OF IMMATURE STAGES OF MUSCA DOMESTICA AT DALLAS, TEXAS

Breeding Number	Placed in Cage	Number	Stage of Development	Media	Additions of Fresh Uninfested Manure	Emergence From	Emergence To	Number Emerged Adults	Length of Larval Stage	Total Development
59	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Horse manure in house	Jan. 20	Mar. 6 10 a. m.	Mar. 6, 6 p. m.	7	Days 23	Days 49
56	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Manure pile generating heat	Every few days about caged infestation	Feb. 8, a. m.	Feb. 9, a. m.	4	15	23+
58	Jan. 14, 1914, 4 p. m.		Eggs freshly deposited	Horse manure in weather shelter	Jan. 20			0	25	
97-B	Nov. 23, 1914		Freshly hatched	Cold horse and cow manure	Occasional small lots			0	67+	
63	Jan. 21, 1914		Larvæ above half grown	Cow manure and straw	Jan. 29	Mar. 17	Apr. 16	27		
64	Dec. 26, 1913		Larvæ and pupæ	Cow manure in small pile				0	42+	
101	Dec. 1, 1914	1,200	Various size larvæ	Cold cow manure in tin box	None			0	73+	
62	Dec. 26, 1913	1,400	Larvæ, half to full grown	Horse manure and straw	Feb. 5			0	90+	
57	Dec. 26, 1913	600	Larvæ less than one-half grown	Horse manure and straw				0	30−	
99	Nov. 7, 1914		Larvæ and pupæ in box	Manure pile generating heat	Every few days	Dec. 3	Jan. 12	273		
100	Dec. 1, 1914	750	Pupæ	Cold cow manure in tin box	None					
65	Dec. 30, 1913	1,000	Pupæ	Box in manure pile			Feb. 9	All viable		
105	Nov. 7, 1914	Thousands	Larvæ and pupæ	30 bushels cow manure	Until Jan. 14		June 5	142*		About six months
66	Nov. 26, 1913		Larvæ and pupæ	Horse manure, cow manure and straw	None	Nov. 27	May 26	10 or 11 *	115+	About six months

*Over-wintered.

A Normally Infested Manure Pile During the Winter

Between October 7 and November 7, 1914, about thirty bushels of cow manure, waste hay, pieces of boards, and rubbish were allowed to accumulate in a pile which, exposed in the open, became most heavily infested with larvæ and pupæ. The manure pile being warm from generated heat, the conditions were very favorable for development, and to be certain that the infestation was mostly *Musca domestica*, some eight hundred flies were separately bred out by artificial heat. Fresh uninfested cow manure was added to the cage until January 14, and during this time adult house-flies continuously emerged. Additions of fresh manure being discontinued on January 14, the generated heat gradually decreased and caused them to cease emerging by January 30. Prior to this date at least 600 adults emerged normally. With their decrease in number the predaceous *Scatophaga furcata*, as determined by Dr. J. M. Aldrich, increasingly emerged in the cage. This species has previously been pointed out to be predaceous upon adult flies and this was fully confirmed by our observations. The manure pile intentionally remained unchanged in size or form after January 14, and no emergence occurred until April 16. On May 5, three other house-flies emerged and emergence continued until June 5, during which time the total number was at least 142. I believe the emergence in the cage would have been a surprising number of hundreds had the cage been large enough to allow a margin of a few feet on either side of the manure pile to prevent escape of migrating larvæ.

The migration of larvæ has been sufficiently dealt with by Hutchison (1914 and 1915). The larval habit of burrowing into the soil has been graphically illustrated by Dr. C. G. Hewitt (1915). At Dallas, Texas, during the fall of 1914, about 900 adults were observed to emerge into an empty cage six feet from a manure pile; the greatest distance of a single larval migration was at least eight feet. The burrowing depth of the larvæ was not determined, but Dr. Hewitt's diagram shows that they have been found in sandy loam two feet deep, and good numbers were present below a depth of one foot. Attention is called also to the fact that the larvæ pupated far enough away from the manure pile so as not to be affected by the generating heat.

The cage of Breeding No. 105 contained the only accumulation of infested manure on the premises, and yet when adults began to emerge in the cage they continuously increased in number on the walls of nearby houses. It is quite evident that this was due to the larval migration from underneath the sides of the cages.

The failure in so many overwintering experiments to produce adults in spring may be attributed to the absence of soil into which the larvæ could migrate for protection.

In Breeding No. 66, the infested manure was placed in a cage and inundated during two different periods which caused fermentation to cease. This apparently rendered the condition for larvæ more like that of soil underneath a manure pile than that of pure manure. The medium was a mixture of horse manure, cow manure and straw heavily infested, and the individual cow droppings not being well broken up probably served in protecting the larvæ from drowning during the inundations.

Summary

It should be understood that all of the observations dealt with in this paper were made at Dallas, Texas.

1. Adult house-flies having sufficient food, not subjected to fatal temperatures, killed by *Empusa muscæ*, nor destroyed by predators, show increased longevity in indirect proportion to decreases in temperature.

2. The general tendency of adults to seek temperatures above 60° F. necessarily causes a shorter longevity than 91 days, which was obtained in a most favorable abnormal caged condition.

3. The humidity being normal and adults being prevented from warmer temperatures they become inactive at 45° F., crawl slightly at 48° F., and will voluntarily fly at 53° F. Even previously fed adults, if subjected to freezing temperatures, die in less than three days.

4. "Northers," causing sudden drops in temperature, are responsible for a large mortality of flies in the vicinity of Dallas, Texas, yet warm periods occur during mid-winter which permit depositing.

5. There is a possibility that epidemics of *Empusa muscæ* may be caused by a lack of deposition media for flies which are sexually matured and have copulated.

6. Breeding media ranging from 46° F. to 55° F in twelve hours will permit emergence of adults from puparia, but emergence has never been observed at lower temperatures.

7. Great numbers of pupæ near the surface of the soil receive either enough heat to permit emergence of adults which usually succumb to cold before depositing or the temperatures are so low that they become inviable.

8. Young larvæ have been kept for more than 67 days without pupating, but only by occasional additions of small amounts of fresh manure.

9. Larvæ more than one-half normal size have been kept alive for more than 90 days, and still other larvæ of various sizes have been observed to live for 115 days.

10. Adults have been observed to emerge in an empty cage six feet from a manure pile, the pupæ having been produced by migrating larvæ. The greatest larval migration was at least eight feet.

11. In a naturally accumulated and infested manure pile larvæ and pupæ were overwintered. Adults continued to emerge during mild weather in mid-winter as long as manure was added. Emergence stopped when addition of manure ceased, but in spring at least 142 adults emerged.

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SCIARA MAGGOTS INJURIOUS TO POTTED PLANTS

By H. B. Hungerford, *University of Kansas*

During the winter months of 1912 numerous complaints were received concerning a tiny black gnat that was appearing in annoying numbers in conservatory windows and around the potted plants. In nearly every case they were held accountable by the housewife for the lack of thrift of many of her plants—an opinion not shared with any degree of assurance by the writer.

Upon investigation, the gnats invariably proved to be Mycetophilid flies of the genus *Sciara*,[1] and their shiny, black-headed white maggots were to be found in the dirt of some of the potted plants—sometimes in such numbers as to be turned out of the soil in small squirming balls.

Since this was the first time that these flies had been brought to our attention in this relation, we were not only at a loss regarding means of exterminating them, but, moreover, were skeptical as to the actual damage they were doing, being more inclined to attribute the sickly

[1] *Sciara coprophila*. The writer is glad to acknowledge his indebtedness to Dr. O. A. Johannsen of Cornell University for the identification of the flies and for placing at his disposal bibliographical material.

appearance of the plants to some physiological condition of the soil or surroundings.

The meager literature dealing with Mycetophilid depredations was scanned, and recommendations for control were made accordingly. It was very shortly discovered that the remedial measures given were decidedly ineffective when applied against these maggots, and, after running the gamut of the "suggested controls," we were compelled to admit to our friends that in the present state of our knowledge, we knew no satisfactory means of control.

To prevent any future embarrassment of the kind, the writer began a series of experiments, to determine the cause for the infestations, the nature of the injury, if any, the life-history and the control.

Literature

These insects have received but little attention from the economic entomologists, if we may judge from the literature. Most of the references are mere reports of their occurrence or injury. The gregarious migratory habit of some species has been reported from many quarters. Fifteen out of some thirty-five references relating to the biology of members of this family are devoted to noting this phenomenon. While the life-histories of but few have been reported, Beling (1),[1] Bezzi (2), Girard (9), Pastejrik (17), in articles not accessible to us, have dealt with the biology of various species of the genus.[2] Chittenden (5) gives the description of the larva and pupal stages, but the eggs were unknown to him and the length of the various stages not mentioned. Coquillett (6) describes pupation of *Sciara tritici* as occurring in an oval cell lined with a few silken threads. He also noted the eggs of this species as being scattered on the ground or deposited in clusters of twenty or more. He describes the eggs as oval, polished, white, and measuring about 1/10 of a millimeter in length. The length of the various stages was not known.

[1] See Bibliography.

[2] Since writing the above I have had the opportunity to review these papers in the libraries of Cornell University. Beling (1) gathered the maggots of twenty-four species from their breeding places in decaying wood, under fallen leaves in cow dung, etc. He describes the maggots and pupæ, giving in most cases the length of the pupal stage. In three instances he mentions the eggs but does not state the length of the incubation period. Bezzi (2) describes the eggs of *S. analis* as white, oval, twice longer than broad, and with such fine punctures that they appear smooth to the naked eye. The females lay from 200 to 240 eggs in more or less numerous clumps. The incubation period is given as seven days, the larval stage a little over a month and the pupal stage a week.—This article in Italian is perhaps the most complete account of the life history of any Sciara.

Dr. Johannsen, in his excellent work on the Fungus Gnats of North America, gives the description of forty-nine species in the genus *Sciara*, thirty of which are new species described by him, and four are not assigned. A few others are named, the descriptions of which are inadequate. Of these forty-nine species, rearing notes are given for less than a dozen. *S. multiseta* Felt, *agraria* Felt and *coprophila* Lintner were taken from mushroom cellars; *S. fulvicauda* Felt and *ingens* Joh. from decaying roots and wood; *S. pauciseta* Felt from decaying potatoes; *S. Hartii* Joh. and *cucumeris* Joh. from cucumbers, while *S. tritici* Coq. larvæ are reported as feeding in wheat, and *S. sativæ* Joh. was supposed to prey upon puparia of the Hessian fly.

In the species we have studied we have often seen the larvæ, especially the young ones, feeding upon the dead bodies of adults and pupæ of their own kind, but we have not observed them devour the living.

Habits and Economic Importance

The family Mycetophilidæ, to which these flies belong, gets its name from the fact that many of them breed in fungi. The food of the maggots of most species consists of either fungi or decomposing organic matter. However, those of some species of the genus *Sciara* do, on occasion, feed upon living roots of plants. C. A. Hart[1] reports an experiment to determine the food preferences of the larvæ as follows:

> A cucumber plant was potted in clear sand and one hundred of the maggots were placed about its base. These affected the plant, the stem evidently being eaten by them. The same experiment was made with the addition, at one side of the pot, of a cubic inch of decayed horse manure, such as is mixed with earth in growing cucumbers. The larvæ were subsequently found collected about the piece of manure and the plant remained uninjured. Next, a plant was potted in a mixture of manure with earth from the forcing bed infested by maggots. The plant was not injured.

His conclusions are that injury to living plants results only where larvæ are excessively abundant. He further states that:

> In no case were the maggots found attacking a firm, healthy stalk or root of the cucumber plants, but at the least appearance of decay they attacked it in great numbers, gnawing the surface and tunneling through it in all directions.

It was our belief that such would be the case with those species we have studied. But, during the past five years, under all sorts of soils and conditions brought to bear in the flat glass root cages, we must state that it has been our observations that they will attack healthy roots even in pure, well rotted manure and in soils with the optimum amount of dried blood fertilizer. We have frequently watched them

[1] Experiment by Mr. Green recorded in 26th Report of State Entomologist of Illinois.

eating the root hairs of various rootlets and devouring sound, growing roots.[1]

Dr. Johannsen states that:

Florists look upon these little gnats with a suspicion which is more than justified, as the fact that the larvæ feed upon the tender roots of potted plants is well established.

He further states:

I have found larvæ in potatoes, feeding on the sound tissue, on the roots of various grasses, and in tulip bulbs.

The maggots of those species we have studied are almost omnivorous as to feeding habits and the injury to plants becomes apparent only when they are relatively abundant. We have watched a maggot as it devoured the dead pupa of one of its own species, nibbled at flakes of decaying organic matter and then, coming to a live healthy root of a wheat plant, proceed to devour it, following its windings for some distance, eventually eating all of the three inches of root that lay against the glass. Maggots newly hatched seem to prefer the root hairs and often clean a rootlet for some distance, and then work upon its surface.

An examination of the root system of an infested plant often shows it severely curtailed. In Plate 42, figure 6, is the photograph of a geranium where the maggots were abundant. Plate 42, figures 1 and 3 show their work upon a geranium slip.

There can be no doubt as to their injurious work.

This lack of thrift of house plants is more often due to the work of these maggots in the soil than is commonly supposed. Plate 42, figure 2, shows some geraniums that have been injured. In one large conservatory the majority of the plants were ruined. Among them were a beautiful eleven-year old fern, many begonias, colias, etc.

Drs. Chittenden, Hine, and others have reported injuries to peas growing in flower pots, and to lettuce, cucumbers and carnations. Dr. Hine states that they were living in the stems of the carnations. Dr. A. D. Hopkins has called attention to their work upon potato tubers. Dr. Forbes has called attention to their injury to seed corn, and the roots and bulbs of various kinds of flowering plants. Coquillett and Lintner mention them as being injurious to wheat, and we have in our own economic collection of insects, some *Sciara* specimens taken from wheat fields at Solomon, Kansas. They have been several times reported as working upon grass roots and we have found them

[1] These observations have been corroborated by Dr. Charles A. Shull, Associate Professor of Plant Physiology, and others.

boring in the crown of both clover and alfalfa, which leads us to beli that their economic importance has been somewhat overlooked.

Life-History

Technique Used.—The first studies in life-history were attempted by rearing the flies in small potted plants. Here, however, it was difficult to locate the eggs and impossible to observe the maggots. For studying the actual work of the maggots on the roots of plants, a flat glass device was used. This was filled with dirt and a geranium slip started. When this breeding box, shown in photograph Plate 41, figure 8, was placed on its side, some of the roots would come to lie against the glass. Thus when the maggots were found eating the roots, the whole device could be inverted and examined under binoculars.

The fact that the maggots fed upon roots suggested the possibility of carrying the life-history through on slices of potato in petrie dishes. The data for the life-histories were obtained by following the various stages on slices of potato in this manner, or in small potato cones in test tubes.

Dr. Robertson suggested that I sterilize potato in the auto-clave and add yeast—a modification of the banana and yeast plan employed by breeders of Drosophila. I reared one brood through in this fashion in thirty days.

Broods were reared in the soil of potted plants as a general check on the length of the life cycle.

Stages in Life-History

The entire life cycle from egg-laying to egg-laying takes from twenty-four to thirty-two days. The adult female often begins ovipositing the day following her emergence. The egg stage and the pupal stage are quite constant as to the length of period, but an irregularity of several days frequently occurs even among the maggots hatching from one egg clump.

The Egg

The females lay from about seventy-five to one hundred and seventy-two eggs. These eggs are placed in declivities or irregularities of the soil. Often, where the soil has drawn away from the pot or the plant stalks, the female will follow down these crevices as far as possible and oviposit there.

The eggs are usually laid in clusters of from two or three to more than thirty. Individual eggs are oval and measure .24 mm. in length by .12 mm. in width. Clusters of them are quite plainly visible to the unaided eye. When first laid, the egg is of a pale greenish-yellow

PHOTOS BY BEAMER

PHOTOS BY BEAMER

color, but turns to pearly white in the course of a couple of days. About this time the head of the future maggot shows up as a shadowy patch that grows darker until by the end of the fifth day it is black and shiny and the embryo is active within this chorion. The eggs hatch in six days. In Plate 41, figure 4, is shown some egg clusters as they were laid in a small crevice of a potato; and Plate 41, figure 2, shows a female in act of laying—about two times natural size.

Larva

The larva when first hatched measures .65 mm. in length and is transparent. As soon as it begins to feed, the digestive tract shows as a dark line through the body. As it grows the body begins to take on a white color which is due to the large fat bodies within. *Sciara* maggots are characterized by their white bodies and black shiny heads. When grown the maggots measure about six or seven mm. in length and have the appearance shown in Plate 41, figure 5. About the eleventh or twelfth day, they begin to spin their cocoons which consist of a few threads of silk binding together loose bits of earth, fibre and the like. Larvæ of all stages have the power to spin out sheets and fibres of silk and sometimes use this power to form a cover to a tunnel in which they work. The larva preparing for pupation spends twelve hours or more making a very flimsy cell which is only a little more than two-thirds its length.

Pupa

Before pupating, the larva contracts to about 4 mm. and after a quiet period of some hours, changes to a naked pupa which is milky white in color. This gradually changes until just before emergence of the adult, the thoracic part is black and the abdomen shows the pattern of the adult. The pupal stage lasts from five to six days. Pupation usually takes place near the surface of the soil, though pupae are not uncommonly found deep down in the earth—indeed, adult flies are sometimes found imprisoned in deep spaces. The pupæ usually work their way to an open space before coming forth as adults. For this reason the surface of infested soils are often strewn with empty pupa cases.

Adults

The adult male and female of *Sciara coprophila* are shown in Plate 41, figures 1 and 3. These photos show their relative size and characteristics.

The female of this species measures about 3 mm. and the male measures 2.5 mm. Both are very active and are rapid runners though weak flyers. They are prone to hide under bits of earth or leaves on

the surface of the pot and "play possum" if disturbed. They are often found in houses where a few plants are kept during the winter months, and, as a rule, cause little concern. However, when they are being bred in large numbers in the favorable soils of the conservatory, they become a nuisance invading all parts of the house and at this time become especially annoying on the dining table where their accidental landing in butter and cream becomes somewhat trying to even the less fastidious.

Control Measures

The experiments for the control of these insects involved: 1st, protecting the plants by the use of repellents; 2d, destroying the maggots in the soil by the application of contact insecticides and stomach poisons; 3d, destroying the adult flies by the use of traps and poison baits.

Repellents

In this series of experiments, small geraniums in three-inch pots were used. The surface of the soil was covered to a depth of from one-fourth to one-half inch with various substances such as flowers of sulphur, pyrethrum powder, coarse sand, etc., and then exposed in a place where there were many flies and other similarly potted plants as checks. All of these plants were watered with like quantities of water and watered from the saucers. The results were not startling, though there were one hundred and fifteen dead flies near one pyrethrum pot. When the soil was examined the average number of maggots per pot were as follows:

Pyrethrum	5
Dried blood	114
Sand	0
Sulphur	0

From subsequent experiments it is evident that the attractiveness of the dried blood might have lowered the other counts somewhat. For in this connection it may be stated that as a result of exposing plants whose soils contained dried blood fertilizer and plants whose soils were ordinary garden soils, the ratio was an average of seven hundred and fifteen maggots per each pot to seven maggots. The larger number appearing in the soils containing dried blood.[1]

[1] One three-inch pot used in this as a trap was exposed a few days and then the surface of the soil carefully searched for eggs. The egg clusters were more numerous in a crevice between the pot and the dirt and in a similar place at the base of the plant on the shady side. The eggs in this case were arranged in clumps as follows: 8, 7, 5, 1, 15, 20, 15, 9, 21, 5, 9, 3, 5, 10, 16, 5, 7, 5, 2, 9, 5, 6, 3, 7, 2, 15, 8, 6, 2, 1, 3, 17, 5,—a total of 252 eggs, an average of 8− eggs to the cluster.

It was early noted that the flies showed a marked preference for soils having an abundance of moisture. Plants alike in every particular save in the amount of water received showed in one series an average of seventeen for the wet ones and none for the dry—a good suggestion for control, for besides rendering the soil unattractive to adults, the maggots already in the soil perish. However, many plants will not stand the lack of water and so experiments were made to see how well control could be affected by sanding the surface of the pots and watering from below. Besides presenting a surface unattractive to the egg-laying of the adult, the inability of the larvæ newly hatched to get down through the sand was demonstrated.

It also appears that pupæ already found in the soil have difficulty in getting through the relatively dry sand barrier. One hundred pupæ were placed in each of six pots, three of which were covered with one-half inch layer of rather coarse sand and water supplied from below. The counts were 3—1—0, for sanded pots and 97—92—94 for the check pots.

The depreciation in the former case may be normal mortality, or it may mean that some were injured in transferring them to the pots. In practical application of this method under conditions prevailing in our homes where ferns and begonias often predominate, the judicious combination of the methods above noted have given very satisfactory results.

In all the cases that have come to our attention, the presence of these flies has seemed due to soils rich in barnyard manure or treated with dried blood fertilizer. In one instance a lady who found that a large potted Lantana was supplying the flies that had been noticed all the fall, thought to help matters by emptying the remains of the teapot upon the inch of sand that had been placed on the surface of the soil. Some time later we were called in to see where the flies came from. A three-fourths inch layer of tea leaves was found, in the lower layers of which were hundreds of maggots. The maggots had gnawed the base of the tree somewhat but there did not seem to be maggots or pupæ in the sand below. Remedial measures were simple enough.

Destroying the Maggots in the Soil

All of the first efforts at control were directed toward destroying the maggots as they existed in the soil. The recommendations found in the literature were followed but with slight success. These included the use of lime water, kerosene emulsion, hellebore, carbon bisulphide, etc., and to this list were added experiments with: Black Leaf 40, in strength from one part to 1,000, and one part to 100. Sodium thiocarbonate, whale oil soap, borax water, and experiments in which the

soil was saturated with solutions of lead arsenate, Paris green and the like.

Two series of experiments were employed in the above; one with potted plants, soil of which contained maggots, and another in which slices of potato covered with the maggots were embedded in pots of sawdust, thus making simple the observations of the effects of the material used. The results in all of these cases either failed to kill the maggots or injured the plants.

It may be worthy of note here that Hart reports that a solution of from one-half to six per cent of nicoteen brought about premature emergence to the flies, thereby destroying them. He also states that the preparation repelled the larvæ. His work was with cucumber beds in a forcing house. The trouble here arose through the use of comparatively fresh manure as a fertilizer. He noted in this connection that when the manure was well rotted little or no injury followed.

It is to be hoped that the work now being done in various laboratories with nitrobenzine will lead to the discovery of some satisfactory applications for killing underground insects.

Destroying the Adults

Many flies were killed by the use of the following recommended by Sanders in "Minnesota Insect Life":

One-sixth ounce of sodium arsenate dissolved in a gallon of water and a pint of molasses. The flies preferred this mixture to combinations of it with stale beer and orange juice. The plants were allowed to become dry and then the sweetened mixture was sprayed over them with a syringe. They fed upon it greedily. However, under ordinary conditions, complete control could not be effected for the flies were not strongly attracted to it.

We had hoped to try the paradichlorobenzine so strongly recommended a year ago, but have been unable to obtain it even for experimental purposes.

Natural Enemies of Sciara Flies

In two references in literature that have come to our attention, certain Sciara maggots have been accused of parasitism. Mr. Peter Cameron 1875(3) declares them to be internal parasites of Sawfly larvæ. He states that the latter retain sufficient vitality to spin a cocoon inside of which the fly larvæ completes the destruction of their victims. Later, they quit the cocoon and change to pupæ in the ground.

Much later than this, Sciara was credited with preying upon Hessian fly puparia. If these cases are authentic, it is a step beyond the usual scavenger tendency we have so often observed.

However, Sciara maggots and adults are the hosts of a few forms. W. R. Thompson (19) gives an article "Sur un diptere Parasite de la larve d'un mycetophilidie." He found some Sciara maggots infested with parasites which he argues must be larvæ of a "Dexiid" or more probably of a "Tachinid."

In one series of experiments we had a number of three-inch pots of geraniums containing some dried blood fertilizer which were being used as a trap pot in a place where the flies were abundant. One pot sat in the corner of the infested bed and here a small nymph of an assassin bug (*Milyas*) took its abode, with the result that during the nineteen days of its presence there, it quite effectively kept the pot free from eggs.

In our study of the development of the eggs, we were at one time troubled by the predatory tendencies of a small mite which unfortunately we did not preserve for identification.

These same mites were seen to attack living flies, the wings of which held them captive to the moist glass.

There is, however one parasite, a nematode, that most efficiently reduced my stock of flies to the vanishing point just recently. It works within the maggot and reaches maturity there. Though the parasite occupies most of the space within the maggot, the latter is sometimes permitted to become an adult, minus, however, all traces of its organs of reproduction. Plate 41, figure 7, shows an adult female parasite. The life-history of this nematode and its effect upon the host will appear in another publication.[1]

Summary

The life-history of *Sciara coprophila* requires a period of from twenty-four to thirty-two days. The egg stage occupies six days, the maggot stage twelve to fourteen days, or longer, the pupa stage six days and the adults have lived under laboratory conditions about a week. The maggots, though omniverous feeders, are injurious to potted plants through their feeding upon the roots and root hairs.

Soils that are moist and rich in manure or dried blood attract the the flies and lead to the laying of large numbers of eggs in these favored situations, the result being that plants growing in soils of this character are seriously damaged.

The maggots, though resistant to most insecticides, quite readily succumb to drying. Thus, by letting the soils dry out occasionally, little trouble will be experienced. Where a serious infestation occurs, a judicious drying out of the soils, use of dry sand on top of the dirt, and trap pots of dried blood and earth and sprouting grain used to attract egg-laying, will effectually control the pest. The maggots

[1] See also Bezzi (2) for others.

and eggs in these trap pots should be destroyed about every two weeks by submerging in boiling water.

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PLATE 41

Figure 1. Female *Sciara coprophila*.

Figure 2. Female ovipositing showing the wings in nearly their normal position.

Figure 3. Male *Sciara coprophila*.

Figure 4. Eggs of *Sciara coprophila* deposited in a crevice in the upper surface of a bit of potato tuber.

Figure 5. The maggot of above named fly.

Figure 6. Pupa on surface of potato showing the nature of its pupal chamber.

Figure 7. Adult ♀ nematode with egg capsule dissected from an infested maggot.

Figure 8. Device for studying the food habits of the maggots.

Figure 9. Enlarged view of pupa shown in Figure 6, to show the chamber of bits of foreign material tied together with silk fibres.

PLATE 42

Figure 1. Geranium slip killed by the work of Sciara maggots.

Figure 2. Geranium plants that owe their straggly appearance to the work of the maggots in the soil.

Figure 3. Close view of lower portions of plant shown in Figure 1.

Figure 4. Begonia plant in a poorly drained vessel with a soil rich in manure. An ideal place to breed Sciara.

Figure 5. Corn roots riddled by the maggots.

Figure 6. Geranium plant and its curtailed root system.

NOTES ON THE CONTROL OF THE WHITE PINE WEEVIL

By S. A. GRAHAM

Yearly the white pine weevil, *Pissodes strobi* Peck, takes its toll of young white pines and Norway spruces, and in recent years it has received considerable attention not only from entomologists, but from foresters and nurserymen as well. A number of control measures have been suggested, some of which are undoubtedly valuable under favorable conditions.

During the past season the writer has applied different materials at various strengths as sprays and washes to the young pines, in an

effort to find a control for this pest in nurseries. Although the experi-ments were not on a large enough scale to be conclusive, still the results in some cases were very gratifying.

Spraying in forest plantings is of course economically impossible, but if an effective material can be found it should prove to be of the greatest value in commercial nurseries and in ornamental plantings.

Approximately five hundred adult weevils were freed during the early spring in the plots treated in order that a heavy infestation might be insured.

The results of the experiments are set forth in the following table:

EXPERIMENTS ON WHITE PINE WEEVIL

Material	Date of Application	Method of Application	Strength	Injury	Trees Treated	Trees Weeviled
Kerosene emulsion	Apr. 26, 1916	Painted	1 to 3	Considerable	10	5
Creosote emulsion	Apr. 13, 1916	Sprayed	1 to 2	None	10	3
Creosote	Apr. 13, 1916	Painted	Pure	Badly injured	10	0
Carbolineum	Apr. 13, 1916	Painted	Pure	Growth stunted	10	0
Creosote	Apr. 13, 1916	Sprayed	Pure	Very slight	10	0
Carbolineum	Apr. 13, 1916	Sprayed	Pure	None	10	0
Soluble sulphur	Apr. 26, 1916	Sprayed	4 lbs. 100 gal.	None	10	4
Lime sulphur	Apr. 26, 1916	Sprayed	1 to 8	None	10	5
Scalecide	Apr. 26, 1916	Sprayed	1 to 25	None	10	[illegible]
Powdered lead arsenate	May 6, 1916	Sprayed	3 lbs. 50 gal.	None	10	3
Powdered lead arsenate	May 6, 1916	Sprayed	2 lbs. 50 gal.	None	10	2
Paste lead arsenate	May 6, 1916	Sprayed	5 lbs. 50 gal.	None	10	4
Paste lead arsenate	May 6, 1916	Sprayed	10 lbs. 50 gal.	None	10	2
Calite	May 6, 1916	Sprayed	1 to 50	None	10	3
Calite	May 6, 1916	Sprayed	2 to 50	None	10	3
Carbolic emulsion	Apr. 26, 1916	Sprayed	1 to 3	None	10	4

CHECK TREES

Group	No. of Trees	No. Weeviled
1	30	8
2	6	2
3	10	3
4	10	5
5	10	4

The check trees were scattered in groups through the stand an[d] were infested as shown in the above table.

From the above tables it is evident that none of the materials use[d] proved effective with the exception of the creosote and the carbolineum. Lime-sulphur at scale strength, which has been recommended as deterrent, in this trial at least, proved valueless. Neither was [it] found possible to poison the adult weevils with arsenicals, althoug[h] very strong solutions were used. Since the pine weevil works onl[y] on the terminal shoots it is only necessary to apply the spray or was[h] to that part of the tree.

Before either carbolineum or creosote can be unreservedly recommended more extended experiments will be necessary, for there seems to be some danger of injury to the trees. The carbolineum showed less injury than the creosote. In no case did either material kill a shoot but the growth of the trees injured was stunted or stopped altogether.

In addition to these sprays and washes tanglefoot was applied to forty trees. The purpose was to determine whether the weevil flew to the terminal or crawled up the tree from the ground for feeding and oviposition in the spring.

Two bands were placed around the stem of each tree, one just above the topmost whorl and one on the trunk just above the ground. It was thought that the weevils crawling up from the ground would become entangled in the lower band, those alighting in the branches and completing the journey to the terminal by crawling would be caught in the upper band, and only those which flew directly to the terminal shoot would escape.

In order to insure a heavy infestation two hundred adult weevils were freed in the tanglefoot plot. The day following their introduction a large proportion of these weevils were found collected below the lower bands, but none were found on the terminal shoots, and none were found caught in the tanglefoot. Not a single time during the season was a weevil caught in any of the bands.

Up to the fifteenth of June none of the trees treated with tanglefoot were infested. On the twenty-first of July, however, three weeviled shoots were found in the plot. It is possible that the tanglefoot became glazed and hard enough, during the cold rainy weather the latter part of June, to permit its being crossed by the weevils.

Out of the thirty check trees in this plot eleven were weeviled.

From these results it is safe to say that the three substances tanglefoot, creosote, and carbolineum deserve further trial on a larger scale.

Further results from these and other experiments on weevil control now under way will be published later.

NOTES ON THE TWELVE-SPOTTED CUCUMBER BEETLE

By R. A. Sell

WILL THE TWELVE-PUNCTATA BECOME A FLOWER BEETLE?

The Twelve-spotted Cucumber Beetle or 12-punctata (*Diabrotica duodecim-punctata* Oliv.) is becoming more numerous in southern Texas. Four years ago comparatively few of these beetles could be found about Houston and these worked upon cane and truck crops, but this year they can be found most anywhere and they attack a great number of plants. Owing to an unusual period of dry weather the

cultivated crops that they prefer were not plentiful before the 10th of June but the beetles were very much in evidence; working upon cultivated flowers, ornamental shrubs and occasionally upon trees and vines. During April, May and the first ten days of June they were found on two hundred and eighty plants—besides the ones which they commonly feed upon: spinach, kale, peas, cucumber, melon, cantelope, pumpkin, beet, mustard, turnip, peanut, corn, cane and coffee-bean, they were noticed on peaches, plums and strawberries and also on such plants as petunias, four-o'clocks, narcissus, wisteria, sweet-peas, jack beans, catalpa, morning glories, touch-me-nots, cape jasmine, and many others. While they sometimes gnawed the leaves of morning-glories, wild sweet potatoes, touch-me-nots and four-o'clocks, they seemed to prefer the pollen, the essential organs or the petals.

To gain some idea of the range of their distribution on native plants at one particular time an extensive trip was made through the woods and fields that were in the wild state or at least as free from cultivated plants as possible. On April 28 they were found on wild plants as follows: *Erigeron* sp., *Rudbeckia hirta*, *Cathartolinum rupestre*, Asteraceæ, *Medicago hispida*, *Allium helleri*, *Echinacea pallida*, *Hartmannia speciosa*, *Chenopodium album*, *Plantago aristata*, *Daucus pusillus*, *Cornus stolonifera*, *Verbena bracteosa*, *Vicia cracca*, *Lantana macropoda*, *Ptelea mollis*, *Monarda fistulosa*, *Erythrina herbacea*, *Xanthoxalis corniculata*, Apiaceæ sp., *Verbena stricta*, Smilax, *Verbena officinalis*, *Laurocerasus caroliniana*, *Carpinus caroliniana*.

In most instances they were working upon the flowers, usually the pollen.

Feeding Habits; Effects of Changing Food

Some experiments in adapting them to different kinds of food were tried and in every case they were able to change from an exclusive diet of one kind of food to another without any more serious consequences than a loss of appetite for a few days. Several kinds of plants they would not eat, even after a fast of eight or ten days.

While they will thrive on cactus blossoms the leaves of this plant do not agree with them. Under ordinary conditions they will not eat cactus leaves but after twenty-eight beetles had been kept without food for four days a supply of cactus leaves was given to them and they ate rather sparingly. In twenty-four hours eight of them were dead but the remaining twenty lived sixteen days with no other food when two more died. Some of them became quite lively on this diet and after twenty-two days' imprisonment began to copulate.

It appears that the *12-punctata* is not as hardy an insect as the *soror*. It is by no means as ready to eat anything that is convenient but it shows a decided ability to meet conditions of shortage in a particular kind of food.

Hibernating, How They Spend The Winter

Preliminary investigations seem to indicate that not much is definitely known as to how the *12-punctata* spends the winter. A large part of the observations made upon the hibernation of this insect consists of inferences drawn from the behavior of allied species that have been carefully studied in many localities but such analogies cannot always be relied upon to hold even with a very closely allied species. It is quite probable that the way of spending the winter for this beetle depends upon many conditions as: duration and intensity of cold weather, rainfall and sunshine and the prevalence of food plants. Mr. F. H. Chittenden of the U. S. Department of Agriculture is collecting data from several localities concerning the habits and life-history of the *12-punctata*. If this method is pursued for a few years the exact effect of the various factors that control hibernation can be ascertained.

With Mr. George Findlay Simmons of Rice Institute the writer undertook to observe the hibernating of a number of *12-punctata*. In the early part of December when the beetles became scarce it seemed that they would soon hibernate. The great storm of the preceding August had destroyed most of the foliage, and the leaves, grown after that, were too tender to stand the frost, hence the woods were much more barren than usual. The last wild plant that they really worked on was the coffee bean (*Daubentonia longifolia*) and throughout the entire winter if a coffee bean plant could be found, in some sheltered spot in the woods, it would be tenanted by one or more of these beetles and some fresh gnawed notches along the edges of the leaf would show where the insect had worked. At first the belted cucumber beetle (*Diabrotica balteata*) could be found with the *12-punctata* but these disappeared about December 15.

The Department of Biology of Rice Institute has constructed an outdoor vivarium with a portion enclosed only by wire screen. In this enclosure where the conditions were essentially the same as outdoors, thirty-two beetles were installed. First they were supplied from time to time with fresh leaves but as they showed no disposition to hibernate the supply was not renewed. They were active at all times. On dull days a beetle would take a position on a twig with its thorax drawn forward as though it was about ready to raise its wing covers, and draw its forelegs slightly above its body with the antennae either forward or twitching slightly. While it might hold this position for hours it was by no means asleep. The position of this beetle when asleep is that of repose—the abdomen is relaxed, the wing covers carefully drawn together and the legs firmly planted against the resting twig.

This position seemed to indicate a response to some instinct for hibernation and was carefully watched for several weeks but they did

not hibernate. The insects did not appear to be especially plump and heavy but they no doubt possessed some form of fatty or energy producing tissue as shown by experiments that were made. Dr. Huxley suggested that there might be such material stored in the bodies of the insects which in a measure would obviate the necessity for hibernating under certain conditions.

Stored Up Energy

It has been noted by several observers that these beetles cannot continue on wing for any great length of time and that if they are obliged to turn often, as in trying to escape from a room, they soon fatigue.

Five beetles that were captured the day before on spinach were turned loose in a room 36 x 60 and kept on wing until they could not be stimulated to take to wing. Feather dusters, horns, squawkers and lifters were tried as a means of keeping them on wing but the most satisfactory results were obtained from the use of a small hand bellows. A piece of cloth saturated in camphor was tied over the nozzle. A beetle was considered fatigued when this appliance failed to make it fly. One of the males was fatigued in eleven minutes and the other one in sixteen minutes while it took twenty-two minutes to fatigue one female, twenty-six minutes for another and thirty-two minutes for the last.

On another test under similiar conditions (November 6) with five females, they were fatigued with an average time of twenty-two minutes. These were fed on spinach three days and then fatigued in an average time of twenty-six minutes. After a fast of five days they were able to stay on wing twenty-eight minutes.

December 17 five males were fatigued with an average of sixteen minutes, but one of them was fatigued in eight minutes while it took twenty-four minutes to fatigue another one.

December 19 five females that had been without food for about two weeks were fatigued in thirty-two minutes.

As there seemed to be a steady gain in ability to keep on wing after fasting, records were kept to show how long they had fasted with their average time. This was known as Lot 1. A fresh lot of five was brought in from a turnip patch December 20. This was known as Lot 2.

Lot 1

Dec. 19	Fatigued	in	32	min.	after	fasting	11	days.
20	"	"	30	"	"	"	15	"
21	"	"	34	"	"	"	16	"
22	"	"	31	"	"	"	17	"
24	"	"	34	"	"	"	19	"
25	"	"	38	"	"	"	21	"
27	"	"	33	"	"	"	23	"
28	"	"	33	"	"	"	24	"
29	"	"	36	"	"	"	25	"
30	"	"	35	"	"	"	26	"
31	"	"	38	"	"	"	27	"

Jan.	1	Fatigued	in	37	min.	after	fasting	28	days.
	3	“	“	34	“	“	“	29	“
	4	“	“	39	“	“	“	32	“
	5	“	“	37	“	“	“	33	“
	6	“	“	36	“	“	“	34	
	7	“	“	38	“	“	“	35	“
	8	“	“	40	“	“	“	36	“
	9	“	“	39	“	“	“	37	“
	10	“	“	38	“	“	“	38	“
	11	“	“	41	“	“	“	39	“
	12	“	“	39	“	“	“	40	“
	13	“	“	42	“	“	“	41	“
	14	“	“	36	“	“	“	42	“
	15	“	“	42	“	“	“	43	“

LOT 2

Dec.	26	Fatigued	in	24	min.	after	fasting	6	days
	27	“	“	22	“	“	“	7	“
	28	“	“	26	“	“	“	8	“
	29	“	“	20	“	“	“	9	“
	30	“	“	23	“	“	“	10	“
	31	“	“	22	“	“	“	11	“
Jan.	1	“	“	24	“	“	“	12	“
	3	“	“	26	“	“	“	14	“
	4	“	“	25	“	“	“	15	“
	5	“	“	27	“	“	“	16	“
	6	“	“	23	“	“	“	17	“
	7	“	“	26	“	“	“	18	“
	8	“	“	26	“	“	“	19	“
	9	“	“	28	“	“	“	20	“
	11	“	“	30	“	“	“	22	“
	12	“	“	26	“	“	“	23	“
	13	“	“	24	“	“	“	24	“
	14	“	“	26	“	“	“	25	“
	15	“	“	31	“	“	“	26	“
	16	“	“	33	“	“	“	27	“
	18	“	“	35	“	“	“	29	“

In general terms there is a gain in endurance corresponding to the time of fasting. One of the beetles in Lot 2 died January 18. January 12, five females were taken from a cage containing about sixty beetles which had been kept since November with plenty of food While they appeared lively they were fatigued in fourteen minutes. They were tried on different days but some one of them would usually give out in six or eight minutes. After a fast of fourteen days their average was eighteen minutes and after sixteen days they were fatigued in twelve minutes. Under the conditions it seems hardly probable that they had become accustomed to confinement. Would it not seem that nervousness attending the unusual conditions of confinement had interfered with their life processes and prevented the usual storage of energy producing material? Within limits it seems that the longer they fast the greater is their power of endurance! Do they prepare for winter by storing tissue that is available for migrating purposes in

localities where they do not need to hibernate? Is it possible that this material becomes more available for transmission into energy as the time for them to begin a search for food approaches? Does exercise tend to make the food material available? They could not be kept successfully in a cage too small for them to fly about.

While observations were not made so as to form a definite conclusion, it appeared that these insects could endure a fast much longer when exercised even in this violent manner than when confined in a reasonably warm room. It is certain that the beetles that were exercised to fatigue almost every day without food were much more lively than those kept in cages with plenty to eat.

Field Habits

On the 18th of July an experiment was begun with the object of studying their habits of distributing themselves over the fields. The country around Corpus Christi, Texas, had been without rain for fourteen months until the first part of July when showers, more or less local, began falling. These showers continued until there was so much rain that farmers could not keep the weeds out of the fields. Here was an area of six counties in which it seemed that very few beetles had spent the winter, hence all or nearly all that were present had lately come in from the irrigated districts of the lower Rio Grande valley.

One hundred and sixty-seven beetles were marked by painting their wing covers with a dash of India ink. The next day but three of them could be found. Four hundred and twenty-four beetles marked in like manner disappeared so completely that only five could be found the next day. One evening thirty beetles were located on plants where they were spending the night but none of them returned to their respective plants the next night. Several other experiments were tried with similiar results. It appears that at this season under such conditions the beetles are not influenced by a "homing instinct" or even a locality instinct. On August 2 some young larvæ were found.

THE PRIVET MITE IN THE SOUTH

By E. A. McGregor, *Bureau of Entomology*

Introduction

In connection with the observations at Batesburg, S. C., during the past five seasons on the common red spider, I have had considerable opportunity to study the little known privet mite (*Tenuipalpus bioculatus* McG.[1]). Concerning its origin little seems to be known, but since all our records of the occurrence of the species have been from the seven southeastern states—North Carolina to Louisiana inclusive— it would appear that the privet is confined mainly to this area.

[1] "Four New Tetranychids," Ann. Ent. Soc. Am., Vol. VII, 4, pp. 354-360.

Character of Attack

The species is not entirely confined to privet [illegible] hedges but a marked preference seems to be exhibited [illegible]. A remarkably high percentage of privet hedges are infested [illegible]. resulting damage is often very noticeable. Unlike many other pests [illegible] the privet gains impetus with the approach of fall and the heaviest infestations usually occur in September and October in the South.

The feeding takes place on the under surface of the leaves where reproduction continues until often the leaves are entirely over-run and swarming with the mites in all stages. No marked discoloration is discernible, as is the case with the common red spider, but a yellowing or fading of the infested leaves is usually noticeable. The heavy draining of the vital juices of the leaves through the many feeding punctures causes a marked weakening of the foliage. This, perhaps together with certain toxins introduced by the mouthparts, results finally in the shedding of many leaves until, in severe infestations, the plants become entirely defoliated (see Pl. 43, fig. 1).

One season's defoliation rarely results in the death of privet bushes. A second crop of leaves is soon developed. Owing, however, to the proximity of the bushes, in the case of hedges, this new foliage generally becomes readily reinfested. Upon the destruction of the secondary foliage the vitality of the bush becomes greatly reduced so that either death or great weakness follows. Often the attack centers acutely upon a single bush with the result that it finally succumbs leaving a gap (see Pl. 43, fig. 2) in the hedge which is not easily repaired.

Food Plants

Although by far the commonest host of this pest appears to be privet (*Ligustrum amurense* and other species), we have records of its occurrence on *Rumex acetosella*, *Oxalis stricta*, garden mint (*Mentha spicata*), strawberry, Boston ivy, golden-rod (*Solidago* sp.), the palm, *Phœnix humilis* and on orange and lemon. Doubtless this host list is by no means complete, and the diverse nature of the above species indicates that the privet mite is to some extent a general feeder.

Description

Female—Body crimson, with two rather well-defined eye-like spots on cephalothorax. Widest at posterior corners of cephalothorax, two-thirds as wide as long. The cephalothorax is narrowed considerably anteriorly, and the abdomen tapers to a rounded tip. The body is armed with a pair of weak spines on the anterior body margin medially, similar spines immediately before and behind the emarginate eyes, six at the posterior tip of the abdomen, and a few along the body margin, and scattered ones dorsally. The cephalothorax is hardly half as long as broad, with the anterior margin convex; the palpi greatly resembles the *Tetranychus* type, the penultimate joint bears a strong claw, and the terminal joint (thumb) bears a "finger." The legs are relatively stout, crenulated; forelegs in length three-quarters the width of cephalothorax; four anterior tarsi blood-red in life; all legs bearing several lateral hairs, and a terminal bristle in length equalling the three distal segments [illegible] the [illegible]

chanter of the four anterior legs with a lamellate hair placed dorsally; the tarsi with several terminal appendages including a pair of closely appressed claws, a very long bristle, and the four capitate hairs, so frequently seen in *Tetranychus*.

Length, 0.235 mm.; width (hind margin of cephalothorax), 0.149 mm.

MALE.—The male is decidedly smaller than the female, and the abdomen is suddenly constricted behind the cephalothorax and decidedly more attenuate than is the case with the female. The legs of the male are relatively longer, colorless, and the hairs and bristles are more conspicuous.

LIFE-HISTORY

THE EGG.—The egg is thickly elliptical in linear outlines, and measures .096 mm. by .067 mm. It is blood red in color from the first. The eggs are usually deposited with the long axis perpendicular to the leaf. An effort is made by the female to deposit the eggs in a depression or abrasion of some kind. These failing, she deposits them in old molted skins (see fig. 38c) or in the groove by the side of the mid vein. When oviposition is taking place freely the eggs often become closely packed (like those of Coccinellids), often comprising clusters of several hundred. It appears from our limited breeding experiments that the female deposits usually about twenty eggs.

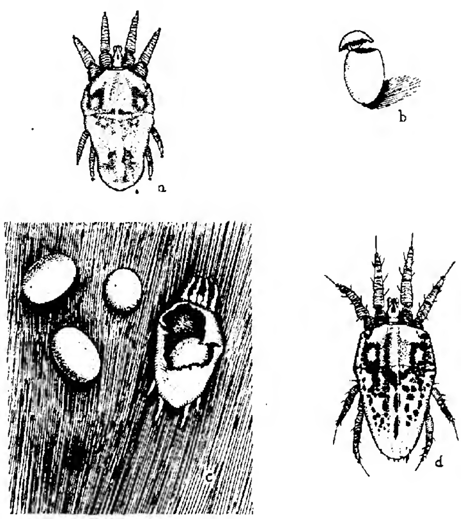


Fig. 38. *a*. Drawing showing outline and color patern of deutonymph of *Tenuipalpus bioculatus* McG.; *b*. Manner of hatching of egg of *Tenuipalpus bioculatus* McG. X 130; *c*. Eggs of *Tenuipalpus bioculatus* McG. on privet leaf. Two eggs are on side, one is on end, one egg has been deposited in the molted skin of a nymph. X 130; *d*. Drawing of adult female of *Tenuipalpus bioculatus* McG.

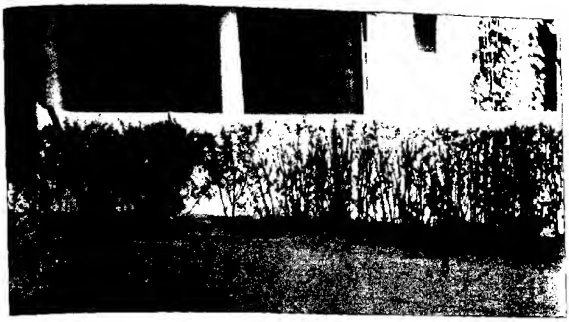


Fig. 1. Damage to privet hedge by the privet mite (*Tenuipalpus bioculatus* McG.). Portions of hedge between A and B have been almost entirely defoliated.

Fig. 2. Photograph of privet hedge showing dead bush which was killed by repeated attacks of the privet mite (*Tenuipalpus bioculatus* McG.).

Incubation

Doubtless, as is the case with the common red spider, the [illegible] of the incubation period varies with the climatic conditions. We find that the length of this period during hot weather is about eight days at Batesburg, S. C.

Table I. Duration of the Egg Period

Period	Duration (days)
June 19 to 27	8
June 24 to July 1	7
June 18 to 27	9
Average	8

Larva

In hatching the eggs rupture transversely near the anterior end. The larva leaves the egg head first. The lid of the egg often remains attached as a cap (see fig. 38*b*). In the one case witnessed the hatching required over thirty minutes. The larva is 6-legged; the body color is a bright crimson whereas the legs are nearly colorless. The just hatched larva is feeble and travels very slowly. The six posterior spines are much more conspicuous in the larval than in the later stages; they are more lamellate and are distinctly serrate. Table II presents the data for four reared larvæ.

Table II. Duration of the Larval Period

Period	Duration (days)
June 27 to July 1	4
June 29 to July 3	4
June 29 to July 4	5
June 27 to July 3	6
Average	4.7

The molt of the larva, as for all other stages, takes place through a transverse rupture at the suture between the cephalothorax and abdomen, quite similar to that of the red spiders. In molting the individual often crawls inside a shed skin of an older stage, and it is customary to see two or three shed skins telescoped one inside the other.

Protonymph

As is commonly the case with mites, the molt to the primary nymph results in an added pair of legs—making eight in all. The feeding protonymph quickly gains in size over that of the larva and becomes of a somewhat darker color.

TABLE III. DURATION OF THE PROTONYMPHAL PERIOD

Period	Duration (days)
July 2 to July 7	5
July 1 to July 5	4
Average	4.5

DEUTONYMPH

Following the molting of the protonymph, which in every respe is quite like that of the larval molt, the appearance of the deutonym (Fig. 38, *a*) is very much like that of the earliest nymphal stage. differs only in the increased size, the slightly deepened color, and th greater reduction in size of the spinous appendages. Table IV presen the results of the two bred deutonymphs.

TABLE IV. DURATION OF THE DEUTONYMPHAL PERIOD

Period	Duration (days)
July 1 to July 5	4
July 1 to July 5	4
Average	4

GENERATIONS

From the foregoing it will be seen that the development of a genera tion of privet mites takes place about as follows:

	Days
Incubation period	8
Larval period	4.7
First nymphal period	4.5
Second nymphal period	4
	21.2

A generation in summer time, therefore, requires about thre weeks for completion in the latitude of Batesburg, S. C. It seen probable that in South Carolina there are six or seven generations i the course of a season. This has not been definitely determine however.

LONGEVITY

The rearing of *Tenuipalpus* was beset with several difficulties suc as predators, humidity control, rain, etc. Although an effort was ma to simulate natural conditions, entire success was not attained. In spite of this we believe that the conditions surrounding our experiments were not sufficiently inimical to greatly influence the results. Of our four experimental females the individual longest under observation lived 17 days within the isolation cell and deposited in that time 18 eggs: the next longest record was 14 days in which time 13 eggs were deposited.

REPORTED OCCURRENCES

Dade City, Fla. Injury to privet. W. W. Yothers.

Olando, Fla. Privet hedges largely defoliated in the fall and spring 1913. W. W. Yothers.

Charleston, S. C. Much damage to privet in 1913. W. W. Yothers.

Auburn, Ala. Much defoliation and damage to privet hedges. Dr. W. E. Hinds.

Agricultural College, Miss. Considerable destruction to privet hedges on the campus and at other points in Mississippi. R. W. Harned.

Baton Rouge, La. Defoliation of privet. E. S. Tucker.

Batesburg, S. C. Frequently inflicts severe damage to privet hedges. Author.

CONTROL

insecticides have been tested against this species. Lime ve practically complete mortality. Following are the results t.

Sprays	Mortality
sulphur (Thomsen Chem. Co.)	99%
ium sulphid	90%
ne sulphate	Less than 5%

ECTS OF FREEZING ARSENATE OF LEAD PASTES

(Preliminary Paper)

R. ADAMS DUTCHER, *Department of Chemistry, Oregon Agricultural College, Corvallis*

INTRODUCTORY

From time to time inquiries have been received at the Oregon Experiment Station relative to the use of arsenate of lead pastes which have been frozen during the winter months. Fruit-growers have observed in certain instances that the appearance of the pastes after freezing was different from the unfrozen material and some men have even insisted that the insecticidal value of the spray had been impaired by freezing.

Manufacturers of some of the commercial pastes advise that all frozen materials be shipped back to the factory or thrown away; while others maintain that freezing has no effect on their product.

The same question was brought to the writer's attention while teaching the chemistry of insecticides to a class of agricultural students.

One student maintained that a prominent fruit-grower was forc to return several hundred pounds of arsenate paste to the manufactur and it was observed that the frozen paste was much more granul than the original material.

In talking the question over with Mr. A. L. Lovett, Station Ent mologist, it was agreed that a number of letters should be written prominent entomologists and manufacturers, asking them to state if their opinion the arsenates of lead were harmed by freezing. Ninete letters were received in answer to the inquiry. Eight of these men (per cent) took the stand that freezing had no effect on the efficien of the arsenate sprays. Six specialists (31.6 per cent) stated that the was no doubt in their minds as to the harmful effects obtained a under no conditions should the frozen arsenates be used. Fi writers (26.3 per cent) were either doubtful or confessed to no defini knowledge regarding the question.

Mr. Richardson of the New Jersey Experiment Station stated th Mr. C. S. Cathcart, Station Chemist,

> obtained a sample of frozen arsenate of lead and made a careful analysis of it. I was unable to discern any change in the amount of arsenic oxide, water soluble a senic, etc., in this sample and came to the conclusion that freezing did not in any w alter the chemical composition of the material.

W. E. Britton, State Entomologist for Connecticut, presented th following statement:

> We know that it must freeze, and we have never hesitated to use it in our work t following season. Sometimes the mechanical condition is changed somewhat, b this comes more from drying than from freezing. If it becomes dry, as you know, is apt to be lumpy, and it is hard work to again pulverize it, so that it will remain i suspension or so that the particles will be finely divided.

A prominent manufacturer wrote as follows:

> As you know, arsenate of lead in the form that ours is in, known as the "hydrogen," is a very tight combination, and a very stable compound. We have experimented a number of times in freezing our material, and then mixing it with water, for suspen sion tests. Also, freezing it, and then drying it out, so that it was water-free, an breaking it up. In all our experiments we have never been able to alter the physica and mechanical values of our arsenate of lead paste through freezing. It never brok down in any way, causing an injurious effect on foliage.

In support of the harmlessness of using frozen arsenate the manage and entomologist for another chemical manufacturing house states:

> So far as I have seen, practically all brands of lead paste of recent manufactur lose nothing in efficiency on being frozen. With some brands the solid matter has tendency to settle more hard in the bottom of the container and consequently is mo difficult to get into proper suspension after freezing, but I have purposely made se eral tests on rather extensive areas and in every case the results in worm control w

just as good with the frozen lead as with the same brand of lead before freezing, the only objection being the slight extra work needed in getting the paste properly mixed with water.

The research department for a commercial house also supported this view as shown in the following letter:

We have found that if the frozen arsenate of lead is allowed to stand in a warm enough place so that it can thaw out, there is apparently no difference in the form of paste arsenate lead. It is barely possible that the physical condition of this frozen lead when thawed is not quite as smooth as when originally made, but this is very hard to state authentically as the difference is so awfully small. We have had a considerable number of samples of arsenate lead analyzed after they have been frozen and thawed out and there is no indication whatever that the soluble arsenic has increased from the original amount that was in it when manufactured. As the soluble arsenic is the biggest indication as to the changes that might take place, we think we are perfectly safe in stating that no chemical change has taken place.

[illegible] manufacturer says:

[illegible]gations indicate that the chemical properties of arsenate of lead are not [illegible] way by freezing, but the physical properties are to the extent that it [illegible] moisture separation, and it sometimes causes the material to become gran[illegible] coarse and because of this there may be trouble by clogging the nozzles. Howe[illegible] this frozen material can be worked up into a good, smooth paste, and it can be if the grower is willing to go to the trouble to do so by the slow addition of water and [illegible]ing a good paddle, it will be in entirely good condition to use.

In opposition to this view Mr. L. Haseman of the Missouri Station writes:

[illegible]know—if arsenate of lead paste is permitted to freeze, it tends to form a [illegible]paration and more difficulty is encountered in keeping it in suspension.

[illegible] W. [illegible]. Schoene of the Virginia Station contends that:

The general impression is, however, that once paste lead arsenate has become thoroughly dry it no longer has any value.

The manager for one of the houses manufacturing a paste used in large quantities on the Pacific Coast is quite emphatic in showing the harmful effects of freezing the arsenate pastes. He writes in part as follows:

With reference to your inquiry regarding arsenate of lead in the paste form after it has been frozen, would like to say that so far as I know, the publications and statements of the manufacturers are not based on experimental data, but are based on a knowledge of how these things act when compressed and on actual experience. For instance, most manufacturers have had at some time, experience on frozen arsenates of lead and after thawing them out, they have found that the paste itself gives up a great deal of its original water and that it was impossible to put this arsenate of lead back into its original form, as denoted by such tests as the difference of the suspension in water, adhesive properties, etc. Freezing has a tendency to granulate the

paste to such an extent that its smooth mixing properties, suspension properties and adhesive qualities are considerably injured. Also it has been shown by a great many complaints which have come to the personal knowledge of the writer during his experience, that a frozen arsenate of lead had been used in the spraying applications and apparently did not control the worms. It has been quite evident from investigations made of such complaints, that the trouble was in using the frozen material and the reasons why it was not active, I am inclined to believe, are because of the injured properties of adhesiveness, fineness, spreading power, etc. It is only the physical properties that are injured and not the chemical properties. I have seen frozen arsenate of lead dried out and reground and it seemed impossible to put it back in its original smooth state.

No less emphatic is the statement made by the horticulturist for a prominent commercial company:

In reply beg to advise, that the only experience we have had with handling frozen arsenate of lead is that it is rendered physically unfit for use; the paste being exceedingly hard to work up after having gone through freezing process. The powdered is not harmed by freezing according to our experience and I think in the case of both, paste and powdered, there is no important chemical change, which would affect the insecticidal properties of material.

Experimental

In view of the contradictory statements given above, a few preliminary experiments were conducted to determine the effect of freezing on the physical properties of some commercial arsenates of lead.

Six commercial brands of lead arsenate paste and pure samples of acid and basic lead arsenates were each mixed until uniform and divided into equal portions and placed in glass stoppered salt mouth bottles. One bottle from each paste sample was placed in an ice and salt mixture and left for 24 hours. Evaporation was prevented by the use of ground glass stoppers and as soon as the samples had thawed, the water and lead arsenate was mixed thoroughly until a uniform paste was obtained. Many of the frozen pastes appeared much more granular than the unfrozen duplicates.

Exactly 10.3 grams of each of the arsenate samples were weighed and suspended in 1000 cc. of distilled water. This is equivalent to "4 pounds to 50 gallons" as used in ordinary practice. Tests were made on these samples to see if freezing had affected the property of the lead arsenate to remain suspended in water. The following photographs on Plates 44, 45 are self explanatory. (The numbers are in duplicate. N.F. = Not Frozen, F. = Frozen.)

Figures I and II of Plate 44 represent the frozen and unfrozen samples 2 minutes after shaking: Samples 1, 2 and 4 show the greatest difference; the frozen arsenates have a curdy appearance and settle much more rapidly. Figures III and IV on Plate 45 represent the samples as they appeared after standing for fifteen minutes. The striking

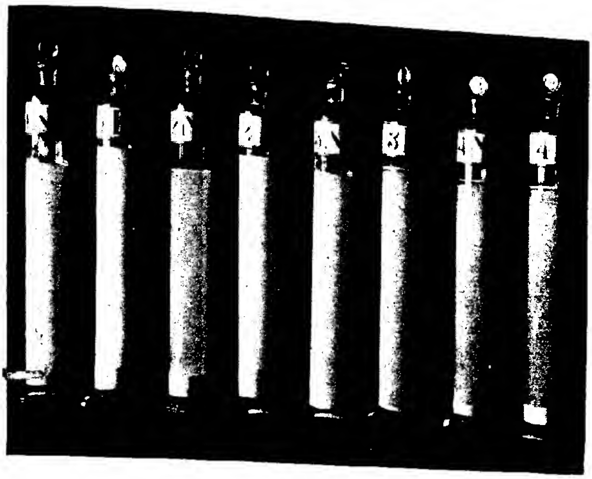


Fig. 1.

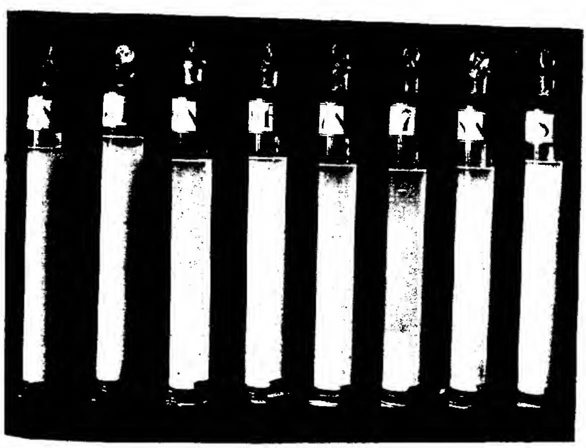


Fig. 2.

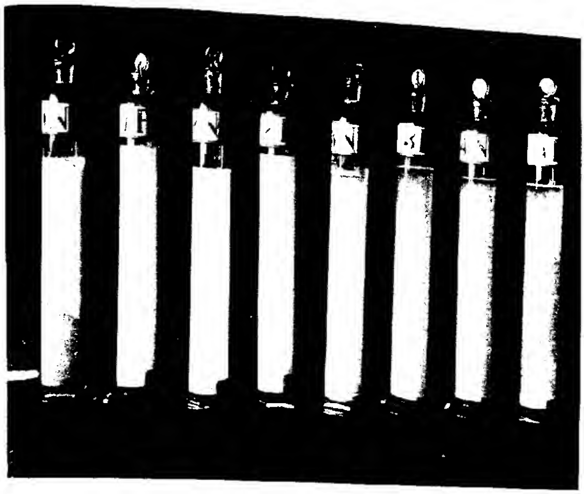


Fig. 3.

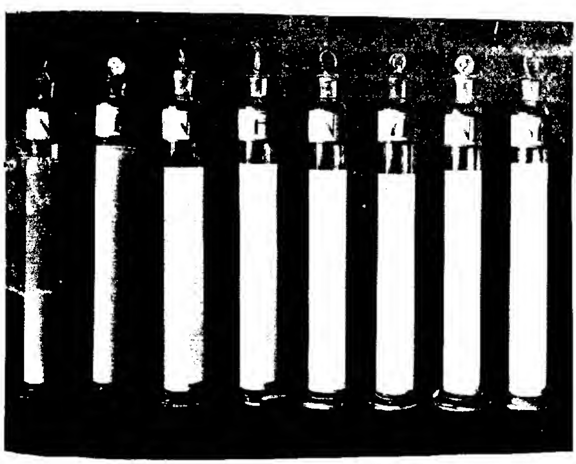


Fig. 4.

ure of this experiment is that different commercial brands behave rently under the same treatment. It is also interesting to note pure lead acid arsenate (sample 7) and pure lead basic arsenate ple 8) show no difference in settling properties after freezing.

order that some idea might be obtained as to the effect of freez- on the adhesive properties of the arsenates an experiment was lucted as follows: Strips of aluminum were cut so that each strip sured exactly $\frac{3}{4} \times 2\frac{1}{4}$ inches, giving an area of 1.6875 square inches each strip. These strips were roughened, by dipping in strong rochloric acid, in order that the arsenate solution might adhere etter advantage. These strips were washed, dried, and weighed. ample 1 was set aside for this experiment because it was representa- of the type affected by freezing. Sample 3 was also chosen be- e its settling properties were not appreciably affected. This ple was a stearated[1] or water-proof arsenate of lead. Sample 6 osen because it represented that class whose settling properties not affected by freezing. In order that no errors be made two ps were dipped into each sample while it was being agitated: these rips were hung on fine copper wires and finally dried and weighed. e results are given in Table I.

TABLE I

Sample of Lead Arsenate	Weight of Empty Strips	Weight of Strips plus Arsenate	Average Weight of Arsenate
....	a. 2.3915 b. 2.3459	2.3925 2.3466	.0007
....	a. 2.4259 b. 2.3532	2.4264 2.3539	.0006
....	a. 2.3067 b. 2.3427	2.3074 2.3439	.0009
....	a. 2.3276 b. 2.3716	2.3278 2.3721	.0003
....	a. 2.4799 b. 2.3281	2.4800 2.3289	.0009
....	a. 2.3190 b. 2.4613	2.3197 2.4618	.0006

ile the above experiment should not be considered as represent- he possible deportment of frozen arsenates of lead under orchard itions, nevertheless it would appear from these preliminary experi- that the adhesive properties of certain arsenate pastes are af- d by freezing.

[1] is type of arsenate is treated with a fatty material with the view of "water- ng" the dried spray in order that it will not be washed from the leaf by rain.

Micro-photographs taken of samples 1, 3, and 6 indicate that t particles of the frozen arsenates are uniformly larger than those the unfrozen arsenates. Figures 5 and 6 of Plate 46 show sampl 1 N. F. and 1 F. as they appeared when sampled with a tube duri agitation of the solution. The particles of frozen arsenate are mu larger and because of this it is difficult to get an even "spread" suspended material.

Figures 7 and 8 representing samples 3 N. F. and 3 F. (stearate also show the increase in size of particles after freezing.

Figures 9 and 10 representing samples 6 N. F. and 6 F. also in cate that although the settling properties of the arsenates are unaffect by freezing, the physical properties of the particles are greatly altere What effect this change will have upon the adhesive properties of t arsenates of lead when sprayed under ordinary conditions is not know The chemical and physical properties of the unfrozen and frozen le arsenate pastes will be studied in this laboratory and their insectici efficiencies will also be compared.

In conclusion the writer wishes to acknowledge his indebtedness t Professor A. L. Lovett who obtained the opinions of specialists in th field, and also to Professor John Fulton and Professor S. H. Graf a assistance in photographic work.

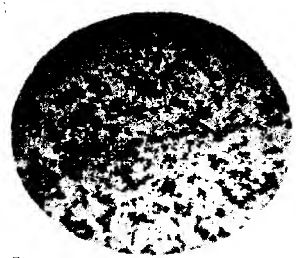
Conclusions

1. The settling properties of some commercial samples of le arsenate paste are affected by freezing while others are not.
2. The microscopical appearance of all lead arsenate pastes e amined were altered.
3. The adhesive properties of lead arsenate pastes may be affect by freezing.

AN INDIAN ANT INTRODUCED INTO THE UNITED STATES

By William Morton Wheeler

During the past summer while helping Mr. S. A. Rohwer to range the Pergande collection of ants recently acquired by the Unit States National Museum, I found a series of workers of a comm Indian ant, *Triglyphothrix striatidens* Emery, that had been tak August 14, 1913, by Mr. E. R. Barber at Audubon Park, Louisian As this interesting insect has only recently spread from its origin home in Southern Asia and has not been previously recorded from t United States, it seems advisable to publish a description and simp drawing of it and to trace its history in myrmecological literature.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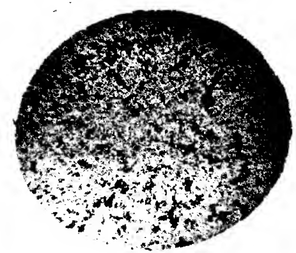

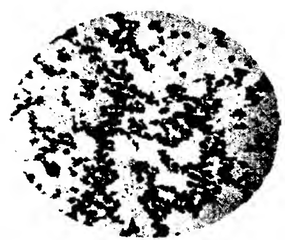
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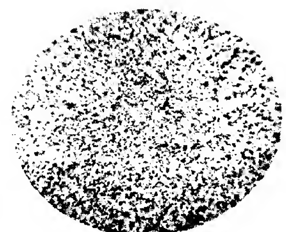
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The genus *Triglyphothrix* Forel is exclusively palæotropical and nprises some twenty described species, about evenly divided between opical Africa and the Indomalayan region. *T. striatidens* was first scribed from Burma by Emery in 1889 as a subspecies of *T. obesa* rn. André and was cited for some time under this name by both Emery nd Forel. Later it was given specific rank. Bingham, who found it ommon and widely distributed in India, Ceylon and Burma, claimed hat it "differs constantly both in Indian and Burmese specimens" om *obesa*, but the differences are not very striking and seem not to be nstant.

The contention that *striatidens* originated in Southern Asia is, of urse, based on its abundance in that region. Its tendency to spread to other tropical and subtropical portions of the Old World was first oticed by Emery, who in 1891 recorded it from Tunis and stated at Ern. André had recently received it from Sierra Leone. In 1901 orel recorded it from the Bismarck Archipelago and in 1902 from ustralia, where it was taken by Turner near Mackay, Queensland. orel described this form as a distinct variety, *australis*, although it iffers only slightly if at all from the typical Indian form. That it is ill very rare or local in Australia is indicated by my inability to find in Queensland or in the large collections of ants sent to me from this nd other portions of the commonwealth. In 1909 I recorded the ccurrence of *T. striatidens* in Formosa, where it was taken by Mr. ans Sauter. In 1912 Stitz described from the Island of Ceram as . *ceramensis*, which, to judge from the description, is hardly more than variety of *striatidens*. In 1913 Forel cited *striatidens* from Sumatra, here it was taken by von Buttel-Reepen. I find in my collection a ngle typical worker taken at Kuching, Borneo, by Mr. J. Hewitt and dealated female taken by Mr. D. T. Fullaway on the Island of Guam.

When common tropical ants begin to spread beyond their native vironments, they are very apt to be introduced with plants into the t-houses of temperate regions. As early as 1906 Bingham found *striatidens* in the propagating pits of the Kew Botanic Garden, in ngland, and in 1905 and 1908 Donisthorpe recorded it as common the Palm House of the same institution.

Forel was the first to notice that *striatidens* had been transported nd had secured a foothold in the New World. As early as 1900 he ceived specimens of a small variety which he called *laevidens*, that ad arrived at Hamburg from Mexico in a living condition, with orhids, and more recently (1912) he announced the occurrence of the ypical *striatidens* in Barbados. In 1902 and 1911 he stated that this nt was actively "becoming cosmopolitan." Mr. Barber's specimens how that it has now made its appearance in the Southern States.

It may, therefore, be expected to take up its residence at no remote date in the hot-houses of the northern states. In all probability it has already established itself in numerous localities in tropical America, from which orchids and other plants are being constantly imported.

The worker *T. striatidens* (Fig. 39a and b) is very easily distinguished from that of any of our American ants by the shape of the head and thorax and the peculiar structure of the soft, dense, erect hairs covering the body. It measures only 2.5 mm. and is orange-brown or dark brown with the first gastric segment blackish and the mandibles, antennæ and legs brownish-yellow. The mandibles are striated, the head, thorax, petiole and postpetiole subopaque, punctate and reticulate-rugose, the rugæ on the upper surface of the head being longitudinal. The gaster is smooth and shining. The head is subrectangular,

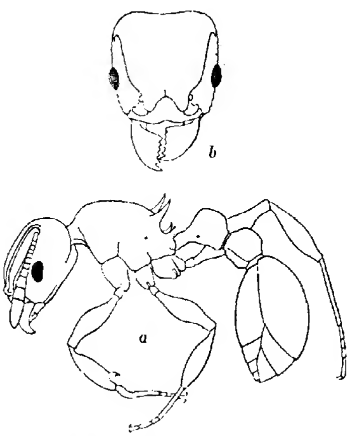

Fig. 39. *Triglyphothrix striatidens* Emery, *a* worker in profile; *b* head from above.

with the frontal carinæ continued backward nearly to the posterior corners and forming the inner borders of broad and moderately deep scrobes into which the folded antennæ fit above the eyes. The thorax is short, without promesonotal and mesoëpinotal sutures, with the episternal angles projecting upward as spines and the epinotal spines rather long, erect, pointed and very slightly recurved. The nodes of the pedicel are somewhat flattened above, the petiole is anteriorly pedunculate, its node a little longer than broad, the postpetiolar node is rounded, about as broad as long, shorter than the petiolar node. The body and legs are covered with soft, dense, erect hairs, many of which are trifid from their insertions and therefore suggested the generic name. The female is a little larger than the

rker, but very similar, apart from the usual differences in the ucture of the thorax, presence of ocelli and wings. The male is still known.

The following literature contains all or nearly all the important erences to *T. striatidens:*

)3. BINGHAM, C. H. The Fauna of British India including Ceylon and Burma Hymenoptera II, 1903, p. 173. (Description of *T. striatidens* and other Indian pecies of the genus.)

)6. BINGHAM, C. H. The Wild Fauna and Flora of the Royal Botanic Garden, Kew. Bull. Misc. Inf. Roy. Bot. Gard. Kew. Add. Ser. 5. 1906, p. 28. (*T. triatidens* in propagating pits at Kew.)

)8. DONISTHORPE, HORACE. Additions to the Wild Fauna and Flora of the Royal Botanic Gardens, Kew 7. Bull. Misc. Inf. Roy. Bot. Gard. Kew, 1908,). 122. (*T. striatidens* in fern and palm houses at Kew.)

15. DONISTHORPE, HORACE. British Ants. Their Life-History and Classifica-ion. Plymouth, Wm. Brendon & Co., 1915, p. 341. (*T. striatidens* common in Kew Gardens.)

39. EMERY, CARLO. Formiche di Birmania e del Tenasserim raccolte da Leon-rdo Fea (1885–87) Ann. Mus. Civ. Stor. Nat. Genova (2) 7, 1889, p. 501. (Orig-nal description of *T. striatidens.*)

)1. EMERY, CARLO. Revision Critique des Fourmis de la Tunisie. In Explor. Sc. Tunisie 1891, p. 4. (*T. striatidens* recorded from Tunis and Sierra Leone.)

)0. FOREL, A. Fourmis Importees. Bull. Soc. Ent. Suisse 10, 1900, p. 284. (*T. striatidens* var. *lævidens* imported into Hamburg from Mexico with orchids.)

)1. FOREL, A. Formiciden aus dem Bismarck-Archipel. Mitth. Zool. Mus. Berlin, 2, 1901, p. 10. (*T. striatidens* in Bismarck Archipelago.)

)2. FOREL, A. Fourmis Nouvelles d'Australie. Rev. Suisse Zoöl. 10, 1902,). 449. (*T. striatidens* var. *australis* described from Queensland.)

)2. FOREL, A. Les Formicides de l'Empire des Indes et de Ceylan. Pt. X. Journ. Bombay Nat. Hist. Soc. 14, 1902, p. 704. (*T. striatidens* recorded from Burma, Ceylon and "tout le continent de l'Inde. Cette espèce tend a devenir osmopolite.")

2. FOREL, A. Myrmicinæ nouveaux de l'Inde et de Ceylan. Rev. Suisse Zoöl. 10, 1902, p. 239. (*T. striatidens* subsp. *orissana* described from Orissa.)

1. FOREL, A. Apercu sur la distribution géographique et la phylogénie des Fourmis. Ie Congr. Internat. d'Ent. Bruxelle, Aug. 1910, 2, 1911, p. 83. (Cos-mopolitan distribution of *T. striatidens* mentioned.)

2. FOREL, A. Formicides Neotropiques. Part IV. Mem. Soc. Ent. Belg. 20, 1912, p. 1. (*T. striatidens* in Barbados.)

3. FOREL, A. Ameisen aus Sumatra, Java, Malacca und Ceylan, Gesammelt von Herrn Prof. Dr. von Buttel-Reepen in den Jahren 1911–1912. Zoöl. Jahrb. Abth. f. Syst. 36, 1913, p. 82. (*T. striatidens* in Sumatra.)

)9. WHEELER, W. M. Ants of Formosa and the Philippines. Bull. Amer. Mus. Nat. Hist. 26, 1909, p. 336. (*T. striatidens* in Formosa.)

Scientific Notes

The Velvet Bean Caterpillar. The velvet bean caterpillar has damaged thousands of acres of velvet beans in Florida during the past month, and little effort has been made by the farmers to control it. The so-called "cholera" (*Botrytis rileyi*) is now becoming effective in the field and will probably kill 90 to 95 per cent. of the caterpillars, as it does about this time each year.

R. N. Wilson.

Alfalfa Caterpillar. The most notable recent damage caused by insects in Southern Arizona was that of the alfalfa caterpillar, *Eurymus eurytheme*. The worms were especially numerous, and had it not been for a contagious disease which finally brought it under control, the damage would have been much more severe than it was. Irrigation of certain fields proved at this time to be an almost certain check upon the outbreak, since the added moisture was conducive to the further development of the disease, and the worms died within a few days after the water was applied.

V. L. Wildemuth.

A Plague of Leaf-Hoppers. On the evening of August 30 the city of Columbia, S. C., and suburbs were visited by myriads of leaf-hoppers belonging to the species *Drœculacephala reticulata*. These "hoppers" were so abundant on the main thoroughfare in the city as to cause very much annoyance to pedestrians. Offices, restaurants, ice-cream parlors and moving-picture houses were infested and some of them were forced to close up for the night. A band that was playing on the top of an eleven-story building was compelled to quit for the evening. On the following night the leaf-hoppers were again present but in small numbers.

P. Luginbill.

Moving Lights Versus Stationary Lights in Phototropism Experiments. Recently, the writer had the opportunity of witnessing the operation of a machine designed to capture the adults of injurious species of insects. A light was used to attract the insects, and on flying near the burner a powerful suction of air created by a gasoline engine whirled them into an inner chamber with such force as to kill the softer ones and cripple the harder species such as beetles and grass-hoppers. The machine was mounted on a truck which was drawn along the edges of the fields of a sugar plantation. Whether it is really efficient has not been determined, and as it is not now being operated there has been no further opportunity to observe it in action.

It was noted that considerable numbers of moths of *Diatræa saccharalis* and *Laphygma frugiperda*, especially gravid females, were attracted by the light. As these species are seldom found at trap lights which have been operated at Audubon Park for several years, it would seem that there must be a difference between these lights and the light used in the machine. As lights of various intensities and colors have been tried at Audubon Park, however, the writer believes that the difference lies not in the lights themselves but in the fact that the lights at the Park are stationary while the light on the machine is moved about from place to place among the fields and thus attracts one group of insects after another. In fact, the attraction of group after group could very readily be noted. When the insects were abundant the truck was stopped for one or two minutes, and when the cloud of insects had disappeared, either settling again or being sucked into the machine, the mules were started and the machine was driven a few yards further on. Possibly the mere motion of the light exercised some attraction which stationary lights do not possess. Other possi-

actors are the noise of the gasoline engine and the walking of the mules and opers of the machine through the grass, the noise and the general disturbance prob causing more insects to fly than would have been attracted solely by the light.

T. E. HOLLOWAY.

n the Distribution of the Imported Cabbage and Onion Maggots.[1] In recent lications, *e. g.*, one published this year,[2] the authors state in regard to the imported bage maggot, "According to published statements it has now spread through the United States and Canada, and caused injury wherever its food plants are wn. Some entomologists, however, consider this questionable and regard another cies, *Pegomya fusciceps* Zett., which is a general feeder, as responsible for the ury in the Southern Atlantic States."

his remark requires a little elucidation. For many years entomologists and ers have reported the cabbage maggot and the onion maggot as occurring in Texas other Gulf States, whereas these species are not known to occur there but are resented by the related seed-corn maggot (*Pegomya fusciceps* Zett.). This last cies is generally distributed in the United States, and is often concerned in injury cabbage and onion where the true cabbage maggot (*Pegomya brassicæ* Bouché) l the important onion maggot (*P. cepetorum* Meade) are generally believed, or re proved to be, the principal enemy. Considerable has been written on this ic, and the main purpose of this note is to call attention to the fact that the true bage maggot positively does not occur, permanently at least, south of New Jersey ar as we can learn, and is somewhat limited, if not entirely so, to the more northern tion of that state, if, indeed, it occurs at all south of the middle of that state. m that point southward it is replaced by the seed-corn maggot which does conerable damage to vegetables and other plants grown in that region.

t may be remarked at this point that the imported onion maggot has about the ne distribution as the cabbage maggot, and when the onion maggot and the cabge maggot are reported from the South, it is the seed-corn maggot which is actually ng the damage.

This opinion is based on specimens which have passed through the writer's hands a period of years, and have either been identified or the indentifications confirmed such authorities as Coquillett, Walton, and F. R. Cole. The different species not so difficult to determine provided both sexes, especially the males, are properly unted.

F. H. CHITTENDEN, *Bureau of Entomology, United States Department of Agriculture.*

[1] Published by permission of the Secretary of Agriculture.

[2] See Britton, W. E., and Lowry, Quincy S., Insects Attacking Cabbage and lied Crops in Connecticut. Conn. Agr. Exp. Sta. Bul. No. 190, Jan. 1916, tom. Ser., No. 23, p. 3, and others.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1916

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. Photoengraving may be obtained by authors at cost. The receipt of all papers will be acknowledged.—E

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Every working scientist appreciates the value of a comprehensiv bibliography or index along his special lines. Entomologists hav been admirably served in this respect, up to recent years, by the *Bibliography of American Economic Entomology*—a series of publication covering the period to the end of 1904. The decade following ha been provided for by the as yet unpublished *Index of American Economic Entomology*, a work which will not appear till at least two year have elapsed subsequent to the period covered. Such a work is valuable in proportion to its completeness *and timeliness*. It is unfortunate that it could not have been published earlier. The Index will doubtless be published soon and unless the matter receives due attention, we may have a similar experience in relation to an Index covering the next five- or ten-year period—two years of which have practically elapsed. The work is too useful to be dropped and it should be so complete and comprehensive as to make unnecessary the compilation of minor special indexes which are to be found in many entomological offices. Moreover, each number should be issued within six months of the end of the period covered. It is entirely feasible to attain these ends, if it is considered worth while. The writer is of the opinion that more effort has been expended and is being given to special indexes of very limited availability than would be necessary to produce a compilation equally valuable to the specialist and, through early publication, of incalculable assistance to all. We are still of the opinion that the federal government would render a most valuable service to applied or practical entomology by continuing the series

ıd if this is impractical, as appears to be the case, could the Asso-ıtion of Economic Entomologists undertake a more useful and appro-iate work than providing for the preparation and early publication comprehensive indexes to the rapidly increasing and widely scat-red literature of American Economic Entomology?

Review

hynchophora or Weevils of North Eastern America, by W. S. Blatchley and C. W. Leng. The Nature Publishing Company, Indianapolis, 1916, pp. 1–682, figs. 154.

Another beetle book has made its appearance, being a supplement to Professor atchley's Coleoptera or Beetles of Indiana which was published in 1910. It is ıt restricted to Indiana, however, but covers, as indicated by the title, the entire stern portion of the United States and Canada. Much attention has been given the Rhynchophora, and many new genera and species have been described since e work published by LeConte and Horn in 1876, which is not only out of date but ıt of print and the present publication brings the classification to the present. The imary object of the authors is to furnish a standard work on the Coleoptera for e student which will enable him to classify and identify weevils. While the work necessarily technical, many matters relating to synonymy and other more strictly chnical matter have been omitted, and the work has been simplified to meet these quirements. Synopses of families, genera, species and other subdivisions form an ıportant portion of this work, and where these synopses are sufficient for identifiıtion detailed technical descriptions are omitted. Other valuable features of the ıblication are notes on distribution and food habits, the latter particularly being edited to authoritative observers and specialists. A distinct departure from other orks of this nature consists in longer accounts of species of economic importance, ith summarized life-histories, and indications of the principal methods of control. he authors have had the advantage of coöperation on the part of many specialists, hich also adds much to the value of the work. The same is true of the explanation structures used in the classification of this group. Four families are represented. renthidæ, Anthribidæ, Curculionidæ, and Scolytidæ. The work will be needed y all students of Coleoptera, by experiment station and other practical workers, ıd those engaged in teaching entomology. The authors deserve great credit for ıeir careful painstaking work which has covered, without doubt, the labors of sevıal years. The volume concludes with an excellent and very complete bibliography, ystematic, biologic, and economic; a plant and generic index, as well as one covering the new genera and species described. *(Adv't.)*

F. H. Chittenden, *Bureau of Entomology, United States Department of Agriculture.*

Current Notes

Conducted by the Associate Editor

Mr. Christopher H. Roberts, a coleopterist and former president of the New York Entomological Society, died September 29.

Mr. G. H. Hecke has recently been appointed State Commissioner of Horticulture of California vice Dr. A. J. Cook, deceased.

Mr. E. L. Worsham, State Entomologist of Georgia, visited the Bureau of Entomology, Washington, D. C., on September 25.

The members of the Federal Horticultural Board recently visited the fumigation plants located in Boston, Brooklyn and Newark.

Mr. Frank H. Smith, Ohio State University, 1916, has been appointed teaching fellow in entomology at the Iowa State College.

Mr. Kennith Hawkins has been appointed by the Bureau of Entomology to take charge of extension work in beekeeping in the Southern States.

Mr. Louis H. Joutel, the well-known entomological artist of New York City, and former treasurer of the New York Entomological Society, died September 6.

Mr. George N. Wolcott has resigned as assistant entomologist of the Porto Rico Insular Station to complete his studies for a doctorate at the University of Illinois.

Mr. H. R. Hagan, instructor in entomology, Utah Agricultural College, has been granted leave of absence for the coming year to pursue graduate study at Harvard University.

Mr. Alfred Free Swain, formerly of Montana State College and of Stamford University, has been appointed assistant in entomology in the Graduate School of Tropical Agriculture of the University of California at Riverside, Calif.

Prof. H. F. Wickham, who has been temporarily attached to the Wellington, Kans., Laboratory of the Bureau of Entomology, has returned to his home at Iowa City to take up his regular work at the University.

Mr. G. C. Woodin, instructor in entomology, Michigan Agricultural College, and assistant in the Station, resigned October 1 to pursue graduate study at the Ohio State University. His address is 179 South Richardson Ave., Columbus, Ohio.

Mr. E. S. Tucker, formerly of the Louisiana Experiment Station, has been appointed a temporary field assistant of the Bureau of Entomology to determine the spread of the boll weevil in western Texas, and in Oklahoma and Arkansas.

Mr. H. C. Yingling, a graduate of the Ohio State University, has been appointed to an instructorship in the Department of Entomology of the Texas Agricultural and Mechanic College, College Station, Texas. Mr. Yingling entered upon his duties the first of October.

At the Maryland Agricultural College and Station, the following appointments have been made: Mr. C. J. Pierson, assistant in entomology and zoölogy in the College; Dr. Philip Garman, assistant entomologist in the Station; Mr. O. I. Snapp, fellow in insect investigations in College and Station.

r. E. F. Phillips, Bureau of Entomology, went to Chicago on October 23 to ar-
;e for extension work, later going to Amherst, Mass., October 30, to consult the
ciate professor of beekeeping at the Massachusetts Agricultural College con-
ing future work on bee diseases.

r. G. F. White, Bureau of Entomology, has concluded his investigations of bee
ases and will be on furlough until April 1, 1917, at which time he will resume
ct disease investigations and will be connected with the office of Cereal and For-
Insect Investigations.

rrangements have been completed by the Bureau of Entomology for extension
k in beekeeping in Tennessee in coöperation with the State College of Agriculture
Cyrus E. Bartholomew, formerly of the Iowa State Agricultural College, has
n appointed to conduct this work, beginning November 1.

n the Bureau of Entomology Mr. E. L. Skellregg, Sandusky, Ohio, has returned
mherst, Mass., and Mr. A. J. King, Vashon, Wash., to the University of Wash-
on, for further study. Mr. Irving R. Crawford, temporarily attached to the
lington, Kans., field station, has also returned to his studies.

rofessor H. E. Summers, of the Iowa State College, has improved much in health
is working over some of his extensive collections in the Rhynchota. He expects
pend the winter months in the south, as he did last year, making collections and
uperating in health.

Ir. C. H. Richardson has resigned his position as assistant entomologist of the
v Jersey Agricultural College Experiment Station and instructor in entomology
Rutgers College, to take up graduate study in the biochemistry of insects at Colum-
University. His address is 1400 University Ave., New York City.

Dr. E. D. Ball, formerly director of the Utah Agricultural Experiment Station,
been appointed State Entomologist of Wisconsin, with headquarters at Madison,
has entered upon his duties. Dr. Ball takes the place of Mr. J. G. Sanders who
ntly accepted the position of Economic Zoölogist of Pennsylvania.

The following men have recently left the employ of the Bureau of Entomology:
N. Primm, North East, Pa., and George R. Bailey, Gainesville, Fla., terms of
ointment expired. J. G. Hester, Brownsville, Texas, H. L. Weatherby, Rocky
d, Colo., J. I. Hambleton, Madison, Wis., Wm. N. Ankeny, Big Rapids, Mich.,
H. Robinson, Plymouth, Ind., resigned.

Dr. A. J. Cook, State Commissioner of Horticulture in California, died September
at 74 years of age. Dr. Cook was formerly professor of entomology in the Michi-
Agricultural College, and for eighteen years was professor of biology in Pomona
lege at Claremont, Cal. For the past five years he has held the office of Com-
sioner.

Mr. Nathan Banks, for more than twenty years assistant entomologist in the Bu-
u of Entomology, has accepted the position of custodian of insects in the Museum
Comparative Zoölogy, Cambridge, Mass., the position formerly held by Dr.
gen. Mr. Banks took his own library and collection to the museum where he
ered upon his duties November 1.

Mr. F. C. Craighead of the Bureau of Entomology is making a preliminary study
a trouble affecting the oaks in the South Atlantic and Gulf States. The exact

cause of the trouble is not known but it appears to be a combination of *Prionus* affecting the roots, and *Agrilus bilineatus* and *Pityophthorus pruinosus* in the trunks and branches.

Mr. Geo. H. Rea, former state inspector of apiaries in Pennsylvania, has been appointed agent to conduct the extension work in beekeeping in North Carolina, the Bureau of Entomology in coöperation with the North Carolina College of Agriculture and Mechanic Arts, Raleigh. He will be under the administrative supervision of the State Entomologist, Franklin Sherman, Jr. Mr. Rea spent a few days in Washington and left for North Carolina on September 18.

A new greenhouse is now being built for the branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology. It is modeled after the first one constructed for this branch of the Bureau in 1914, and it is to be used for fumigating different forms of insects affecting cucumber and related plants, tomatoes, lettuce, beans and other truck plants grown under glass under different conditions of light, moisture and temperature.

The following men in the Bureau of Entomology have recently been transferred to other work or localities: A. J. Flebut, Southern Field Crop Insect Investigations, to take up work on the chestnut weevils; A. G. Webb, Boston, to Minnesota; H. W. Willis, Newark, N. J., to Brooklyn, N. Y.; Dr. Henry Fox, Charlotteville and Tappahannock, Va., to Clarksville, Tenn.; E. H. Gibson, Mo., to Washington, D. C.; George W. Barber, Maxwell, N. M., to Wellington, Kans.; H. B. Scammell, Brown's Mills, N. J., to Toms River, N. J.; D. G. Tower, Office of Tropical and Subtropical Insect Investigations, to Federal Horticultural Board and stationed at the Port of New York; W. E. Dove, Aberdeen, S. D., to Dallas, Tex.; D. C. Caffrey, Maxwell, N. M., to Tempe, Ariz.; C. F. Turner, Greenwood, Miss., to West Lafayette, Ind.; J. M. Langston, Greenwood, Miss., to Forest Grove, Ore.; C. M. Packard and T. D. Urbahns, Pasadena, to Martinez, Calif.

During October a distinguished party of South Carolinians visited Louisiana and parts of Mississippi for the purpose of obtaining first-hand information regarding the boll weevil. The party was headed by Governor Manning and included the president of the Agricultural and Mechanical College, the director of the Experiment Station, and chairman of the Board of Trustees of Clemson College, and representatives of the State Bankers' and Cotton Seed Crushers' Associations, and several others. It was accompanied throughout its trip by W. D. Hunter. The party made a thorough study, especially with reference to the steps which can be taken in South Carolina, to avoid the losses and demoralizations which have practically invariably followed in the wake of the boll weevil. It is anticipated that the full report of the Commission, which is to be written by Dr. Riggs, president of Clemson College, will be an historic document.

Mailed December 9, 1916.

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